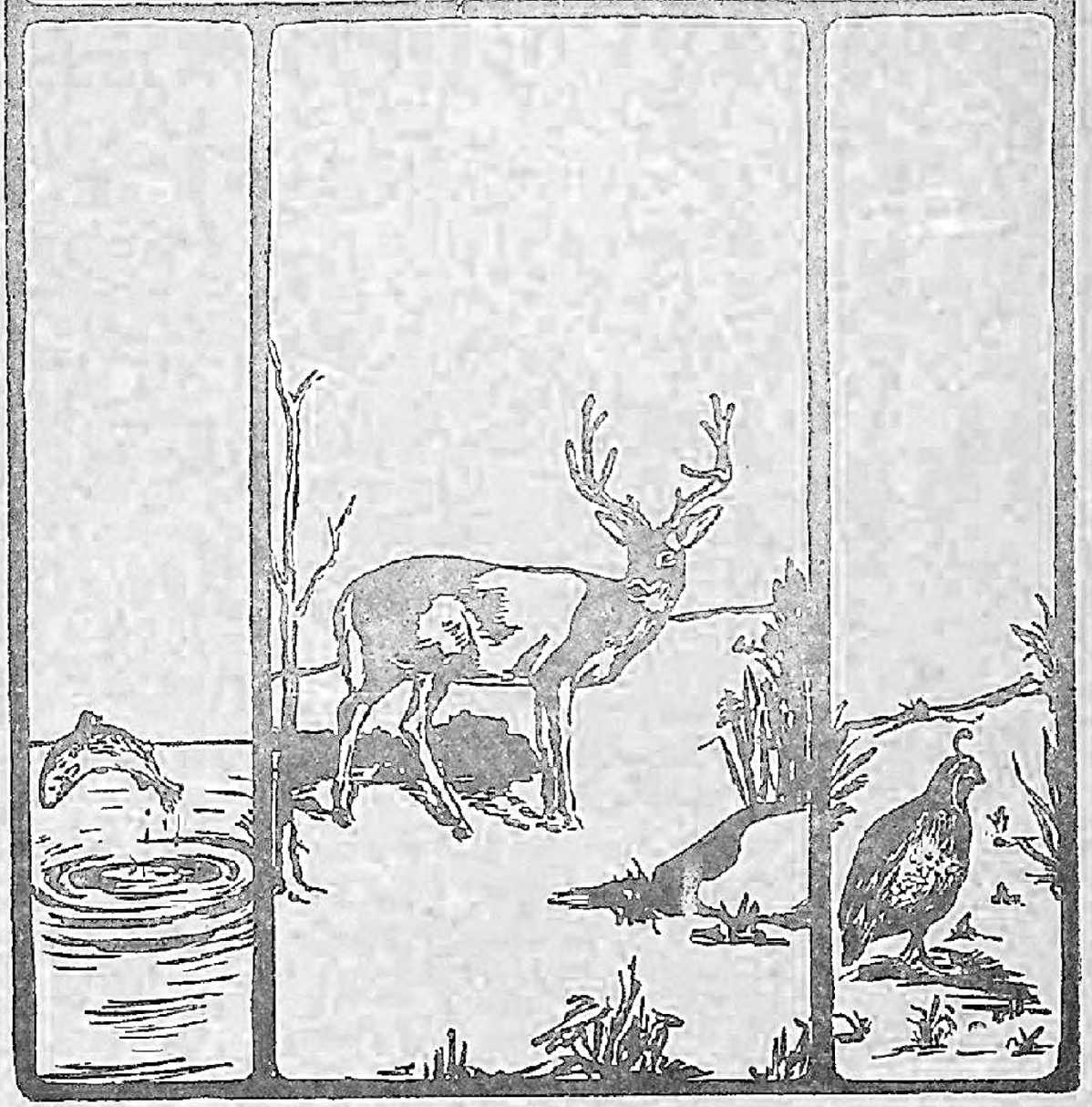
CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 25 San Francisco, April, 1939 Number 2



STATE OF CALIFORNIA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FISH AND GAME

San Francisco, California

CULBERT L. OLSON ..... GOVERNOR
GEORGE D. NORDENHOLT ..... DIRECTOR OF NATURAL RESOURCES

FISH AND GAME COMMISSION

KENNETH I. FULTON, President ..... Sacramento
FRANK W. CLARK, Commissioner ..... Sacramento
PHIL S. GIBSON, Commissioner ..... Sacramento
_____, Commissioner
_____, Commissioner
HERBERT C. DAVIS, Executive Officer, Division of Fish and Game ..... San Francisco

BUREAU OF FISH CONSERVATION

A. C. TAFT, Chief ..... San Francisco
J. H. Vogt, Assistant Chief ..... San Francisco
A. E. Burghduff, Hatchery Inspector ..... San Francisco
L. Phillips, Hatchery Inspector ..... San Francisco
E. V. Cassell, Superintendent Mt. Shasta Hatchery ..... Mt. Shasta
Geo. McCloud, Superintendent Mt. Whitney Hatchery ..... Independence
D. A. Clanton, Superintendent Forest Home Hatchery ..... Forest Home
J. C. Lewis, Superintendent Tahoe Hatchery ..... Tahoe
Ed Clessen, Foreman Fort Seward Hatchery ..... Alderpoint
Earl Leitritz, Foreman Fall Creek Hatchery ..... Copco
Archie Thompson, Foreman Yosemite Hatchery ..... Yosemite
Wm. Berrian, Foreman Big Creek Hatchery ..... Davenport
John Marshall, Foreman Feather River Hatchery ..... Clio
R. A. McCloud, Foreman Kaweah Hatchery ..... Three Rivers
Donald Evins, Foreman Lake Almanor Hatchery ..... Westwood
H. E. Cole, Foreman Basin Creek Hatchery ..... Tuolumne
Peter Topp, Foreman Burney Creek Hatchery ..... Burney
C. L. Frame, Foreman Kings River Hatchery ..... Fresno
Allan Pollitt, Foreman Prairie Creek Hatchery ..... Orick
J. L. Stinnett, Foreman Brookdale Hatchery ..... Brookdale
Merrill Brown, Foreman Central Valleys Hatchery and Fish Rescue ..... Elk Grove
G. C. Tabler, Fish Hatchery Man, Yuba River Hatchery ..... Camptonville
Clarence Chansler, Fish Hatchery Man, Madera Hatchery ..... Bass Lake
H. H. Hewitt, Fish Hatchery Man, Alpine Hatchery ..... Markleeville
R. C. Lewis, Fish Hatchery Man, Hot Creek Hatchery ..... Bishop
Joseph Wales, District Biologist ..... Mt. Shasta
Leo Shapovalov, District Biologist ..... Stanford University
Brian Curtis, District Biologist ..... Sacramento
William Dill, District Biologist ..... Fresno
Elden H. Vestal, District Biologist ..... Stanford University
J. W. Cook, Fish Hatchery Construction Estimator ..... San Francisco
E. R. Varnum, Fish Hatchery Construction Estimator ..... San Francisco

BUREAU OF GAME CONSERVATION

J. S. HUNTER, Chief ..... San Francisco
Gordon H. True, Jr., Economic Biologist and Administrative Assistant ..... San Francisco
_____ ..... San Francisco
Donald D. McLean, Economic Biologist ..... Los Banos
Roy M. Wattenbarger, Supervisor Los Banos Refuge ..... Gridley
L. H. Cloyd, Supervisor Gray Lodge Refuge ..... Calipatria
Russell M. Reedy, Supervisor Imperial Refuge ..... Tupman
Joe Vlasnik, Jr., Supervisor Elk Refuge ..... San Francisco
John R. Wallace, In Charge, Predatory Animal Control ..... Standish
Asa L. Brown, Supervising Trapper ..... Weaverville
John L. McDonald, Supervising Trapper ..... Springville
O. R. Shaw, Supervising Trapper

BUREAU OF GAME FARMS

AUGUST BADE, Acting Chief ..... Yountville
E. D. Platt, Superintendent Los Serranos Game Farm ..... Chino

BUREAU OF MARINE FISHERIES

N. B. SCOFIELD, Chief ..... San Francisco
S. H. Dado, Assistant Chief ..... San Francisco
H. B. Nidever, Field Inspector ..... San Francisco

CALIFORNIA STATE FISHERIES LABORATORY

W. L. Scofield, Supervisor ..... Terminal Island
G. H. Clark, Supervising Fisherics Researcher ..... San Francisco
Frances N. Clark, Senior Fisheries Researcher ..... Terminal Island
Harry C. Godsil, Senior Fisheries Researcher ..... San Diego
Donald H. Fry, Jr., Senior Fisheries Researcher ..... Terminal Island
Richard S. Croker, Senior Fisheries Researcher ..... Terminal Island
J. B. Phillips, Senior Fisheries Researcher ..... Pacific Grove
Paul Bonnot, Senior Fisheries Researcher ..... Stanford University
Geraldine Conner, Fisheries Statistician ..... Terminal Island

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION."

VOLUME 25 SAN FRANCISCO, APRIL, 1939 Number 2

TABLE OF CONTENTS

CALIFORNIA FISH AND GAME is a publication devoted to the conservation of wild life. It is published quarterly by the California Division of Fish and Game. All material for publication should be sent to Richard S. Croker, editor, California State Fisheries Laboratory, Terminal Island, California.

59800

A SURVEY OF DESERT BIGHORN IN DEATH VALLEY NATIONAL MONUMENT, SUMMER 1938[1]

By JOSEPH S. DIXON, *Field Naturalist*, and E. LOWELL SUMNER, JR., *Regional Wildlife Technician, U. S. National Park Service*

INTRODUCTION

Of the various paradoxes which characterize the Death Valley region, one of the most striking is the presence of the desert bighorn (*Ovis canadensis nelsoni*) in the rugged, barren mountain ranges which rise steeply from this lowest, hottest and driest of the desert valleys.

Adapted to the rigorous climate through untold centuries of existence amid these arid surroundings, the bighorn sheep probably enjoyed a relatively tranquil way of life prior to the coming of the white man.

However, in 1880, following the discovery of borax and other valuable minerals, active mining centers gradually developed in various parts of the valley, particularly in the vicinity of water, which was vital both for mining and for human consumption. Even when the sites of human development did not actually center at the springs and water holes, these ancestral drinking places of the bighorn often were boxed up and the water piped away for use elsewhere. In the case of the more remote watering places, the unsuspecting animals were shot from rock blinds built by meat and trophy hunters.

As a result of this competition and persecution by man, the Death Valley bighorn experienced a period of decline which lasted until about 1933. At this time the Death Valley National Monument was established and with the development of a ranger patrol force, poaching for meat and trophies was gradually eliminated. Another circumstance favoring the bighorn was the abandonment of numerous ephemeral mining centers, of which scarcely a trace now remains other than a few rusty fragments of machinery.

About 1937, several bands of the previously elusive bighorn commenced to be seen with some regularity by National Park Service officials, CCC workers and even by the visiting public. In August of that year Assistant Chief Park Ranger Thomas J. Williams and Park Naturalist H. Donald Curry counted approximately 33 bighorn at Quartz Spring These animals were noticeably unsuspicious and on one occasion two rams voluntarily approached the observers to within a measured distance of 20 feet.

In November, 1937, members of the Death Valley National Monument staff suggested that an intensive survey be made of conditions affecting the bighorn and urged that the cooperation of the California Division of Fish and Game be secured for the reason that a knowledge of the bighorn status would be of more than local interest, and because the National Park Service personnel available for the study would be extremely limited.

[1] Submitted for publication, February, 1939. Published by permission of the U. S. National Park Service.

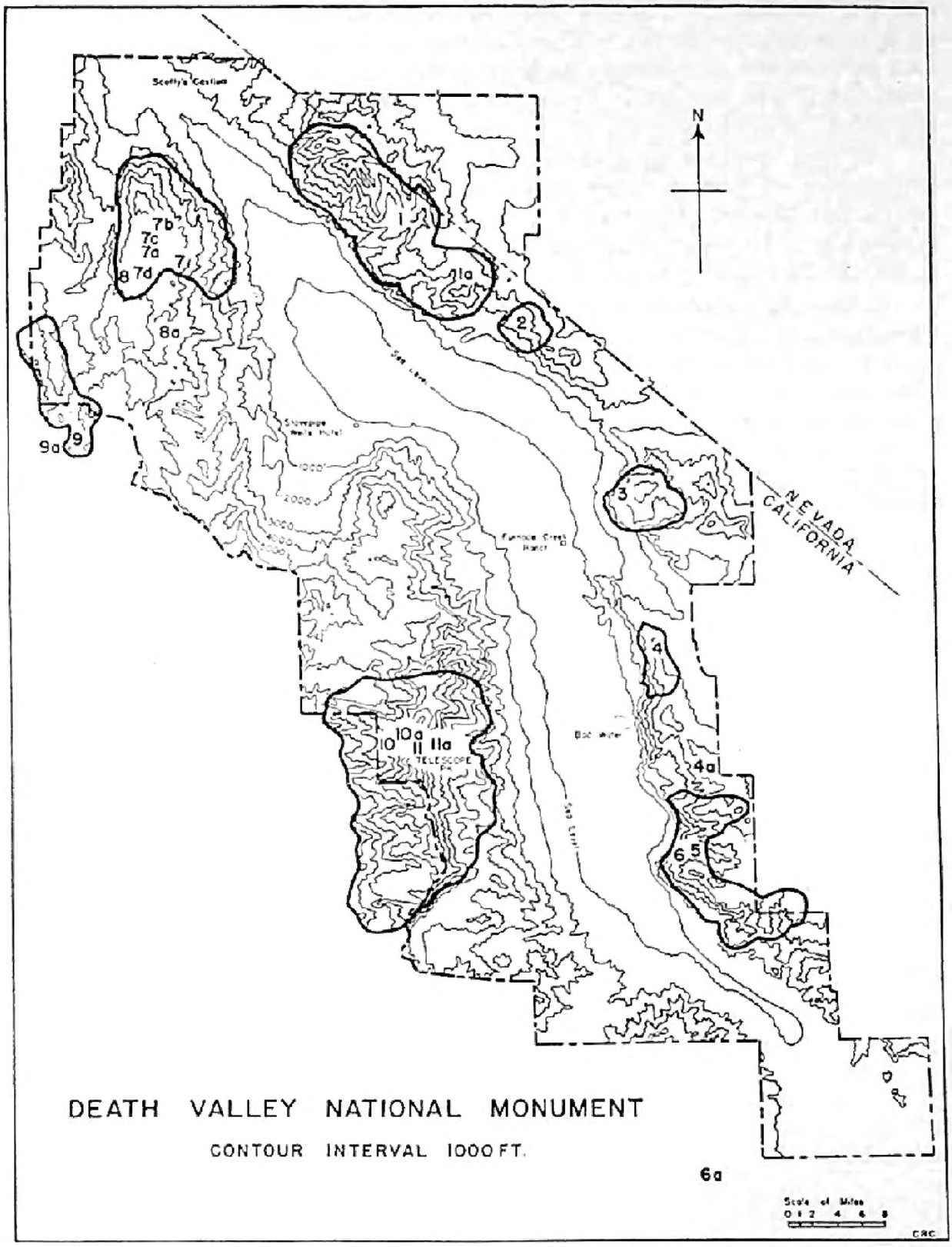


FIG. 26. Death Valley National Monument, showing important known bighorn areas. Numbers indicate springs visited by Dixon and Sumner in September, 1938.

Mr. J. S. Hunter, Chief of the Bureau of Game Conservation, Division of Fish and Game, and Economic Biologists Gordon H. True, Jr. and Donald D. McLean were approached regarding the possibility of a cooperative survey. The California Division of Fish and Game had previously carried on bighorn investigations in the desert ranges south and west of Death Valley and proved to be keenly interested in the Death Valley project.

To our great regret, however, the date of the eighteenth annual conference of the Western Association of State Game Commissioners prevented Messrs. Hunter, True and McLean from accompanying us personally. However, they sent Game Bird Breeders Roland E. Curtis and Otto Rowland, each with an automobile to help us.

Although adverse weather conditions prevented as great accomplishments as had been anticipated, the importance of the services rendered by Messrs. Curtis and Rowland can not be overestimated. Their cheerful assistance under adverse travel conditions, the friendly atmosphere which they contributed to the venture and the feeling of cooperation which they engendered between the two State and Federal departments which had a mutual conservation interest, deserve the highest praise.

The same remarks apply also to the contributions made by the Death Valley National Monument staff. Assistant Chief Park Ranger Williams devoted all the time he could possibly spare to participation in the survey, and Ranger Wilbur Doudna was constantly with us. Without the information and help which they gave, the census would have been practically impossible. A vote of thanks is due Superintendent Goodwin for making every possible arrangement to enable these men to accompany us.

ITINERARY

September 12. Quartz, Burro and Rest Springs. Messrs. Curtis, Rowland, Williams, Doudna, Dixon and Sumner.

September 13. Pinyon and Sheep Springs. Same party except that Dixon remained during this time at Quartz Spring.

September 15. Dodd Spring and Grapevine Wash. Same party as above except that Williams returned to headquarters and Sumner remained at Quartz Spring on the 15th and 16th.

September 16. Leaning Rock. Same party as on the 15th.

September 17. Monarch Mine below Keene Spring; also Fern Spring. Party consisted of Curtis, Rowland, Doudna, Dixon and Sumner. (See Fig. 27.)

September 18. Klare Spring. Same party.

September 19. Leach Spring. Same party.

September 20. Saratoga and Owl Springs. Same party.

The following springs were visited by Dixon, Doudna and Plant Foreman French Gilman after Curtis, Rowland and Sumner had left Death Valley:

September 22. Willow Spring and canyon below; also Greenwater.

September 24. Nevarez Spring; also Lemonade, or Cold Spring.

September 25. Upper Spring, Hanapaugh Canyon.
September 26. Eagle Spring, Telescope Peak; also Birch Spring, Tuber Canyon.

WEATHER CONDITIONS

Weather conditions during the investigation justified the previous contention of the Death Valley staff that July and early August are the best months for counting bighorn. Unfortunately, other field assignments did not permit us to take advantage of this advice. Luck was against us, and during our visit there was rain in varying amounts almost every day in some portion of the mountains adjacent to Death Valley. In some parts of the Monument the run-off was the heaviest in many years. In Ryan Wash the telephone line was destroyed three times during the summer. The road in Emigrant Wash was washed out over a considerable portion of its length. Puddles of water were common in the roadway during our visit and Goodwin states that a lake which measured a quarter of a mile in length was temporarily

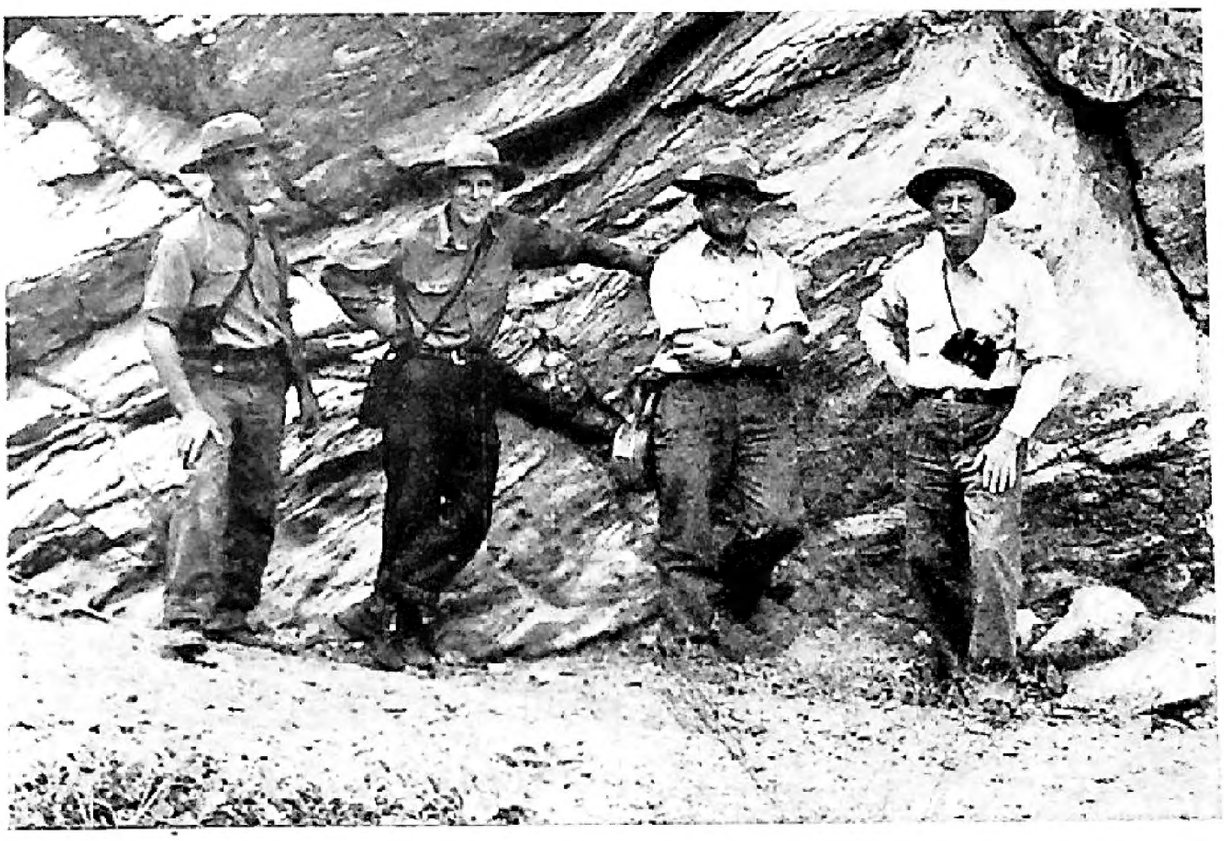


FIG. 27. Messrs. Roland Curtis and Otto Rowland of the California Division of Fish and Game, Ranger Wilbur Doudna of the Death Valley staff, and Field Naturalist Joseph S. Dixon, at the spring by the old Monarch Mine.

present on Harrisburg Flat. At the south end of the valley we found the washes running six to eighteen inches deep with water. Some roads were entirely closed.

Although the average annual rainfall is only one and one-quarter inches in Death Valley, summer cloudbursts are a regular feature in the region during the latter part of August and the month of September, and by filling up the many pot-holes in the rocks they render

the bighorn more or less independent of the permanent water holes, thereby greatly increasing the difficulties of census taking. Williams stated that prior to the summer thunderstorms, the bighorn at Quartz Spring came to water every day. During our visit, however, which followed rains and cooler weather, their visits were less frequent than once a week, thereby multiplying by more than seven the time necessary to spend at a given water hole to obtain bighorn counts. It is hoped that next year the census can be carried out during July, at which time there will ordinarily be no thunderstorms. We feel that this year's investigation has by no means been a failure, however, since it was expected that a program of this magnitude would require more than one summer of field work for completion. Information gained regarding field methods will prove invaluable next year.

WATER HOLES VISITED

The accompanying map (Fig. 26) shows known areas of bighorn concentration which were visited during this trip. Numbers shown on the map are given in parentheses in the following descriptions of the springs to facilitate location.

East Side of Death Valley

Grapevine, Funeral, Black Mountains

Klare Spring (1)

At Klare Spring, which is located in Titus Canyon, the wall about the mouth of the artificial tunnel had been broken down by the heavy rains and weathering. The stream flows for a quarter of a mile down the canyon, forming numerous pools. This flow enables the bighorn to drink without forcing them to go to the spring itself, which is filled with a growth of cattails. Fresh tracks of one ram, three ewes and two yearlings were found along the water course below the spring. Compared with 1935, it is our opinion that the bighorn population in the area has increased, although use of this particular spring does not seem to be very regular.

Lostman Spring (1a)

The water supply at this spring is small, but past experience indicates that it is constant. The animals can not get water at the lower of the two artificially dug holes, but can get it easily at the upper one. A fresh track of one adult ewe was seen at the spring and tracks of two other bighorn were seen nearby. In May, 1935, many tracks were seen. The locality is remote and not likely to be disturbed. (See Fig. 28.)

Lower Titus Canyon

In lower Titus Canyon, fresh tracks of two yearling bighorn were found by Dixon in the bed of the wash where the animals had crossed near the dry mouth of the canyon.

Monarch Mine (2)

Fresh tracks of about twelve different bighorn were found at two watering places, and one ram, three adult ewes and a lamb were seen by Sumner as they left the lower water hole in the early morning. Compared with conditions in 1935, this area showed great improvement in the bighorn population. The flow of water is at least double now what it was then, and where there had been only a few seeps and pools of water in 1935, a stream now flows down the canyon for about one-half mile. (See Figs. 29 and 30.)

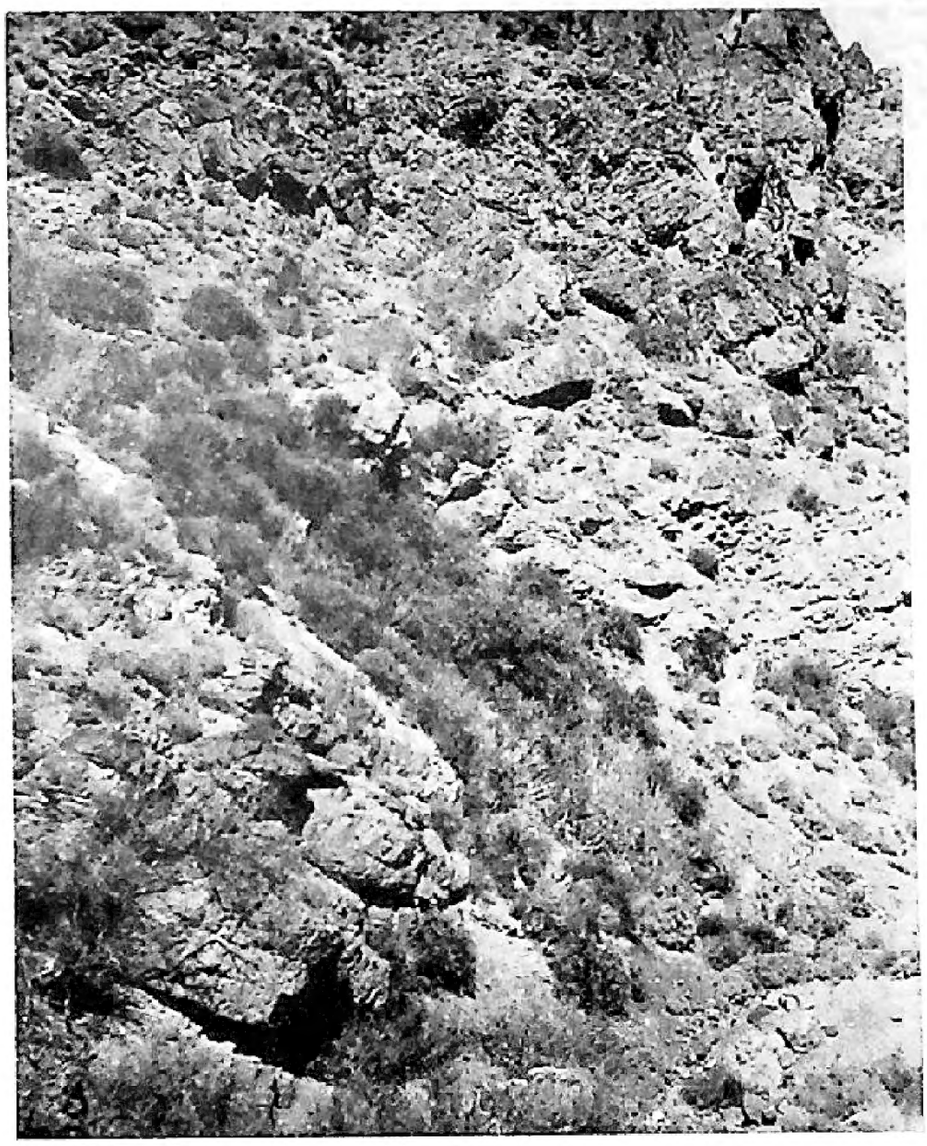


FIG. 28. Lostman Spring in Titanothere Canyon. The cane and other green desert vegetation, although inconspicuous, is diagnostic of a spring in this region.

Bighorn had watered at various places along this stream but the favorite watering place is at the lower end, where the canyon wall closes in to form a rugged box canyon and the stream makes a precipitous drop of about seventy feet. Judging from the stone barricades that were built by sheep hunters in the early days, this must have been a regular and important watering place. The territory is so

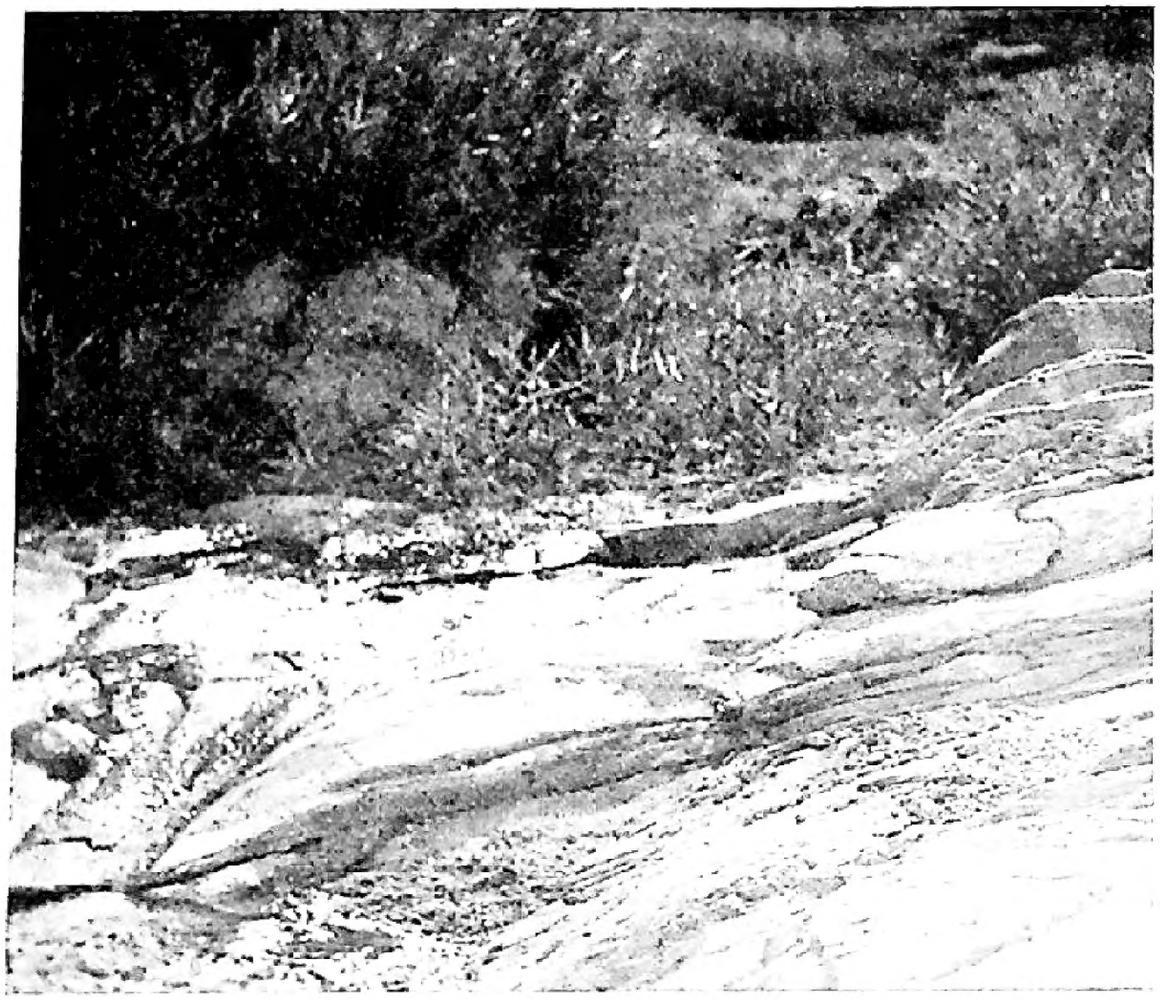


FIG. 29. The large spring near the old Monarch Mine, showing abundant growth of cane in the background and water flowing over the rocks.

FIG. 30. Part of the long winding stream which issues from the spring at the old Monarch Mine and flows down the canyon for a quarter of a mile.

rugged and precipitous that it would take at least a week to gain any fair idea of the total bighorn population. It is believed that our count of twelve bighorn is conservative, and that there is a decided increase of bighorn in this area. The narrow canyon is so long and winding, however, that two or three men would be needed to patrol the stream to obtain accurate counts.

The Monarch Mine has been abandoned for a number of years and there appears to be very little intrusion by white men into this area.

Nevarez Spring (3)

At Nevarez Spring old tracks made during the previous July and August indicated that at least six or eight bighorn had used the upper spring during the heat of the summer. No recent tracks of bighorn could be found, however, and it is believed that the rains had enabled the animals to secure water elsewhere. This locality is only about two and a half miles from park headquarters so that protection is relatively simple.

FIG. 31. View of Death Valley, showing rocky open slope where hunters formerly lay in wait behind rock barricade in foreground, and shot the bighorn as they came to drink at Nevarez Spring.

Although there are a number of springs on the Nevarez property the bighorn utilize only those that lie entirely out in the open nearest the mountain. (See Fig. 31.) In this manner they have an unobstructed view of their approach to the spring, which is important

because the surrounding territory is relatively flat and the sheep have no protecting cliffs within four or five hundred yards of the spring. At this point we found the largest track of a male bighorn encountered on the entire trip. This track was made in firm mud and measured three inches in length and a little over two and a half inches in width, being larger than that made by an eight year old ram observed at Quartz Spring.

The large Nevarez Spring, with mesquite and desert holly (see Fig. 32) is rarely if ever visited by the bighorn.

It is very important, from the wildlife standpoint, that these *upper* springs on the Nevarez property be acquired, as well as the other springs in the neighborhood.

FIG. 32. Luxuriant growth of mesquite and "desert holly" at the main Nevarez Spring, which is seldom or never used by bighorn. Although producing little water, certain outlying springs near the base of nearby mountains are very important from the wildlife standpoint.

Lemonade or Cold Spring (4)

At Lemonade or Cold Spring, water conditions were favorable, there being a good supply in an open mine tunnel which the bighorn had used frequently as a drinking place. This is the only locality in which we found bighorn entering an open tunnel to secure water. The fresh tracks of two ewes and one small ram were found at this spring. Dixon searched carefully for signs of poaching, since this was the place where fresh bighorn skeletons and other signs of poachers' work were evident in 1935. However, careful search failed to reveal any indication of poaching and it is our belief that the bighorn are regaining their former numbers.

Greenwater (4a)

A small supply of water was found in the mine tunnel, the entrance to the tunnel having been closed by a rock and cement wall for several years so that no water has been available for the bighorn. This area lies out in the open and is not near any known suitable bighorn habitat.

Fig. 33. Wild burros, such as the three here shown, frequently congregate in numbers about isolated springs in Death Valley. Here they so trample and foul the water holes that the native bighorn are driven out. Where we found wild burros extensively using a spring, the bighorn were always watering elsewhere.

Willow Spring (5)

We found this spring heavily used and trampled by many burros (see Fig. 33), six being in sight at one time. In 1935 this was one of the best and cleanest water supplies in the region. Now it is so trampled and muddy that we could not find a place where even a man could drink. Careful search in the vicinity failed to reveal any bighorn tracks or droppings and it is our belief that the sheep have been crowded out of the area by the large numbers of burros which water there.

Canyon Below Willow Spring (6)

Water comes to the surface at many points in this narrow canyon, as was indicated by clumps of mesquite and canes. Well down in the canyon we found two flocks of Gambel quail, each consisting of twenty individuals, and in the more inaccessible sections of the canyon where it was too rough for the burros, we found fresh tracks of three bighorn —one male and two females.

An old blind, built of rocks (see Fig. 34), and bleached bullet-punctured bones of bighorn near this water showed that it was an important hunting place in the past.

Owl Spring (6a)

This spring is merely a seepage that has been developed by man. It is located in the open away from cliffs, and we found no bighorn tracks or sign in the vicinity.

FIG. 34. Two flocks of Gambel quail, as well as bighorn, water at seepage places in this rocky canyon below Willow Spring. Old rock blinds (center) used by former bighorn hunters are a feature of such watering places.

West Side of Death Valley

Panamint Range

Leaving Dixon at Quartz Spring (for account of which, see page 85), the remainder of the party visited Burro Spring, Pinyon Spring, Sheep Spring and a deep rocky gorge referred to by the party as the "Bighorn Gorge," with the following results:

Burro Spring (7)

Wild burros visit Burro Spring extensively and their trails radiate in all directions. We heard a band snort after dark and observed several individuals subsequently. Doudna had counted about twenty-five on a previous trip. The bighorn appear not to have visited this spring in recent seasons, according to Williams. In fact, it was our experience throughout the Death Valley region that whenever we

found a spring that was heavily utilized and fouled by a large number of burros or wild horses, no evidence of bighorn watering there could be found.

Pinyon Spring (7a)

Pinyon Spring is a series of quite large seeps on a north-facing slope sparsely covered with pinyon pine. Large numbers of pinyon jays come to water there, also wild burros whose trails radiate inward from all directions.

Doudna saw a large ram accompanied by a smaller bighorn last year but we found no sheep tracks there this time—only burro tracks in great profusion.

Ten burros were seen coming to water on our trip from Burro to Sheep Spring, and others were heard again after dark that night. Probably nearly twenty burros frequent the area.

FIG. 35. The "Bighorn Gorge" on the east side of Tin Mountain, showing ideal bighorn range with rocky escarpments for protection, and brush-covered slopes for food and bedding grounds. The opposite wall of the gorge (not visible) is almost as steep.

"Bighorn Gorge" (7b)

Leaving the main party, Doudna and Sumner continued about a mile north of Sheep Spring, and on the east side of Tin Mountain discovered a deep rocky chasm of splendid proportions which might well be named "Bighorn Gorge." This gorge presented a typical

bighorn habitat with its succession of sheer cliffs and parapets for protection, together with steep, sparsely brushy slopes suitable for feeding and bedding down. (See Fig. 35.)

At the moment when we came to the edge of the precipice, two ewes were discovered on a ledge about one hundred feet below, while two more were observed farther down the slope. The last mentioned two saw us and bounded farther down the slope amid a tremendous clatter of loosened rocks, but, in spite of this disturbance, the two nearer ewes did not take fright immediately but remained for some time peacefully chewing their cuds. Apparently bighorn are not in the habit of looking for danger *above* them and it may have been for this reason that they showed little alarm even though the observers were plainly silhouetted against the sky on the cliff overhead. At length, when Sumner crept within 100 feet of them the loud click of the camera caused them to bound down the mountain side with a crash of dislodged boulders and rubble. Two others, hitherto concealed behind a rocky shoulder, followed them and in the space of a minute or less they had traversed the whole immense slope and had come to a stop a quarter of a mile away. About this time two rams appeared from somewhere and the whole group zigzagged to the bottom of the canyon and ascended the opposite wall, nervously eyeing us from across a chasm which mere man would have required hours of effort attended by considerable danger to negotiate.

Due to the lateness of the day, it was not possible to search for water in this gorge. The indications are that water is near, however, and the region appears to be an important bighorn stronghold. Sheep Spring (such as it is) is only a little more than a mile away and Red Rock Spring, the location of which is still unknown to Service investigators, is said by old-time residents to be quite close.

Sheep Spring (7c)

Sheep Spring is about two miles north of Pinyon Spring and is hardly more than a seep at best, with additional small amounts of water accumulating in nearby pot-holes in the cliffs during the rainy season. The range for bighorn is excellent here, however, as regards food supply. At the time of our visit the seep had dried up and no water was available; evidently, this had happened very recently. There was fresh evidence of the activities of a coyote which had pawed a hole in the moist sand in an attempt to get a drink. (See Fig. 36.) Apparently he had not been successful.

Fortunately, about the time seeps like this one dry up, the bighorn obtain a supplementary supply through the rain-filled pot-holes resulting from the late summer thunderstorms. It is conceivable that the absence of bighorn from certain of the desert ranges which are relatively low in altitude may be due to the fact that these low ranges do not intercept enough precipitation during the late summer to compensate for the drying up of the springs.

Two large rams jumped up from the shade of overhanging rocks and ran off, when the party was 75 feet distant. The bleached bones of two others lay in the vicinity. About three-quarters of a mile up a

nearby canyon we jumped what might have been one of the above mentioned rams, or it might have been another individual. He leaped up from the base of a small ledge and was only 15 feet beneath the party when he took flight.

FIG. 36. "Nose hole" pawed in the sand by a coyote at Sheep Spring in an effort (apparently futile) to obtain water. Nose holes of this sort, where producing water, are used extensively by bighorn, coyotes and other animals.

Rest Spring (7d)

No recent bighorn sign could be found at this spring, perhaps due to the presence of campers.

Quartz Spring (8)

Quartz Spring was visited by all members of the party. Dixon remained here September 12, 13 and part of 14, while the other members of the party went on to Pinyon Spring, Sheep Spring and "Bighorn Gorge." Sumner remained here September 14, 15 and 16, while the other members of the party went on to Dodd Spring, Grapevine Wash and Leaning Rock.

On our first visit on September 12, recent tracks of eight bighorn were found about the spring, which has been dug out, rocked up and covered over by miners who have piped the water a quarter of a mile down the canyon so that it can be collected in a steel tank and hauled by automobile to nearby mines in the region. A provision has been made whereby the overflow from the tank runs into a large, old-fashioned iron kettle which has been buried in the ground and serves as a drinking fountain for the bighorn. The sheep hung around the original spring but were unable to get at the water at the time of our study, although Doudna reports that earlier in the season they did so.

At six o'clock on the morning of September 14, Dixon, who had remained in hiding for two days without making a fire to cook with because of fear of frightening the sheep, saw seven bighorn near the spring. Two were adult rams, which a close examination with the binoculars showed had large horns—seven annular growth rings being plainly seen on one and eight on the other; the horns of the younger ram were perfect whereas the horns of the older ram were broken at the tips. The fresh fall pelage was, surprisingly, reddish chocolate in these two adult rams. This color blended so harmoniously with the

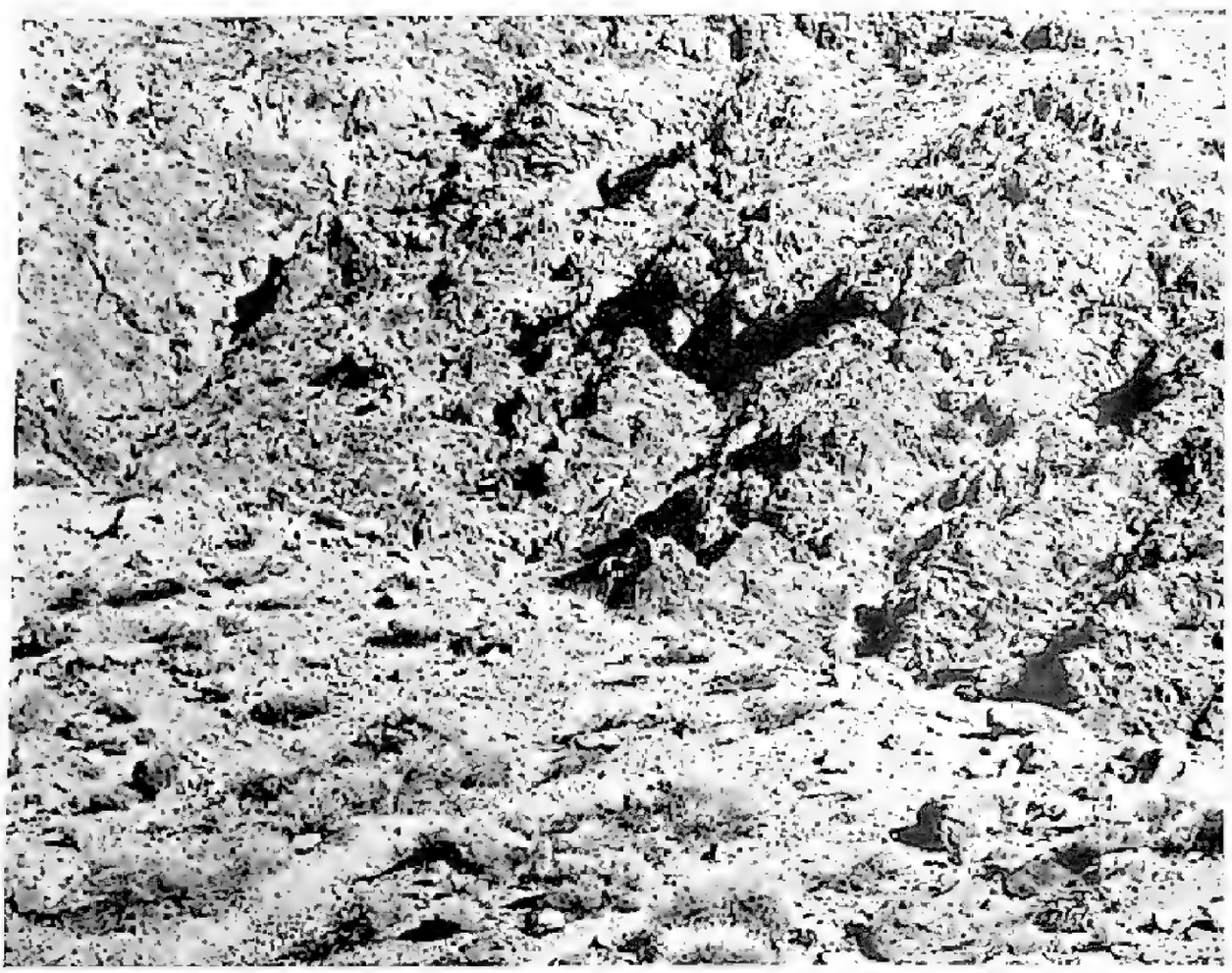


FIG. 37. Bighorn (center) at Quartz Spring en route to water, showing blending of the color of the animal with its surroundings. Two of the many bighorn trails leading to water are visible as they come over the low ridge in the left center and proceed toward the lower left hand corner of the picture.

rocky, chocolate-colored background that it was frequently a matter of several minutes before the animals could be again detected when the observer's eyes were taken off of them.

At eight o'clock on the same morning, a band of five bighorn—two adult ewes, one young ram, one immature female and one lamb—all being led by an old ewe, came running down the hillside to the spring. So far as Dixon was able to discover, there was nothing in the immediate neighborhood to alarm them, and by back-tracking he later found that they had come in from some considerable distance. This band of sheep did not go directly to the spring but went on up into the canyon

above the spring, where several photographs were taken of them at a distance of 100 yards; they worked up into the canyon with amazing speed and ease. One bighorn loosened a number of rocks which, being dislodged, fell into the canyon. Upon hearing this shower of rocks, the two adult rams came running up out of the canyon. As they clambered up the hillside, Dixon secured two photographs of them in their native habitat. However, their concealing coloration was so effective that the animals in the background are difficult to distinguish.

At 2:30 p.m., September 14, when Sumner took the place of Dixon at Quartz Spring and the remainder of the party had left, one of the rams (probably the younger one) appeared on the low ridge between the original spring and the steel collecting tank where the bighorn are

FIG. 38. Bighorn at Quartz Spring just after a futile attempt to obtain water from the upper spring which was boxed up. The dense willows surrounding this spring are visible at the lower left-hand corner of the picture.

now forced to water. He advanced slowly and hesitantly toward Sumner, who was about 125 feet away and not prepared for such an early reappearance (about one-half hour) of the animals following the departure of the remainder of the party. The chocolate-colored ram blended astonishingly well with the chocolate-colored rocks in the background, and the slow stealthy motion of the animal, punctuated by frequent lapses into complete immobility, rendered it difficult most of the time to make him out. Subsequent observations indicated that the bighorn may have been aware of their concealing coloration; at least they made full use of it whether consciously or not. The feeling of security of this ram was emphasized by the fact that Sumner was standing by the automobile in full view at the time and was able to move slowly to the camera, wind it and release the shutter with a loud

click. (See Fig. 37.) Even this did not put the animal to full flight, although he turned around and after a few moments of hesitation walked slowly down out of sight behind the ridge, back toward the upper spring from which he had been trying vainly to obtain water.

In about five minutes, Sumner tiptoed to the upper spring and heard the ram moving about and pawing among the rocks. This, the animal kept up for half an hour—standing quietly for long intervals and then pawing or moving about looking for water. Although only 75 feet away, he was invisible among the thick willows which grew there.

FIG. 39. Same bighorn as in the preceding picture, circling the observer apparently out of curiosity.

At length, after standing at the edge of the willows and looking out, motionless, for long minutes, he came out onto the open hillside only 75 feet from Sumner, who pulled the camera trigger. (See Fig. 38.) At its loud click the ram started and then stared at the photographer an instant before running at a rather slow pace up the hill. When about 200 feet away he slowed down to a walk and then circled Sumner slowly and cautiously. (See Fig. 39.) This type of behavior may be due to curiosity coupled with a lack of any strong natural fear; however, it has led to the death of many a sheep. This ram could have been killed easily with a .22 rifle.

He circled until he was silhouetted on the top of a ridge 200 feet or less away, and there he stayed (see Fig. 40), blowing softly through his nose at intervals, perhaps in an effort to rid himself of nasal bots.

Occasionally one could hear a rock clatter across the canyon, revealing the presence of one or more other sheep, and sometimes this ram would look up there.

At length, running out of film, Sumner left the ram on the low ridge and went back to camp, where he lay in a blind all night about 125 feet from the lower spring. During the night, pebbles could be heard clattering softly near the lower spring, 100 feet from the blind, but in view of later developments it is believed that the ram did not venture close to the water.

The next day, at about 6:30 a.m., before the sun had reached the canyon, Sumner heard rocks, some of them large, bound and crash

FIG. 40. Same bighorn as in the preceding pictures after he had mounted a cliff which provided him with a safe vantage point for prolonged scrutiny.

from a ridge about a quarter of a mile above the lower spring. Several times, too, he heard a low guttural "baa," faint and short—almost a croak—and on one of these occasions saw a ram bounding down the ridge against the skyline. Evidently this was not the same ram as seen the day before because twenty minutes later the familiar soft snort was heard from what looked like yesterday's ram on the *other* side of the canyon, where the animal stood, statue-like, about one-fifth of a mile from the blind. Both rams disappeared, without going to water, when the sun came over the ridge.

At 6:30 p.m. on the same day a ram suddenly appeared in the dusk on the low ridge between the two springs and started toward the water hole. He was about 125 feet away as he passed the blind and the closer he got to the water hole the more hesitant he became. Evidently the original, *upper,* willow-covered water hole is preferred and is visited first even when dry. When the ram got about 50 feet from the water hole he stopped, hesitated, turned back, turned around again and came to a halt, staring first at the blind and then at the spring, indecisively. For the next hour and a half, while it grew steadily darker until he could not be seen, he vacillated thus, sometimes getting down to about 25 feet from the water, only to turn and run or walk fast and fearfully up the slope for a hundred feet and have another long look.

At 8:30 p.m., being still without supper, Sumner got up from the blind and commenced cooking—rattling pots and pans and making other slight noises. There were no sounds of flight, however. After supper was finished and Sumner lay down in the blind for the night, he heard faint stirrings in the rock slide a hundred feet or more above the spring, and several times the guttural "baa" of a ram and also the snorting sound. At closer range, the "baa" resembles more than anything else the boom of the eastern bullfrog, only a little more subdued and the note a trifle shorter.

About six the next morning, just when the birds were first stirring in the dawn, a ram was observed silhouetted on a ridge a sixth of a mile from the lower spring, staring at the blind. Apparently he failed to perceive the observer or else was not afraid. Presently he came down the ridge toward the spring at a rapid walk. As Sumner crouched, watching, he suddenly heard the familiar bullfrog "boom," and from the same direction as the first, another ram was seen hurrying down to water at a trot. When both rams got about opposite the blind and were still 200 feet from the spring, they slowed up, hesitated, looked at the blind and stopped. Apparently, however, they saw nothing to really alarm them, for the second ram now caught up with the first, rubbed his nose against the other's flank and boomed again.

At length one of the rams turned and went straight to the water. He hesitated and started to turn back once, but returned and drank long, without raising his head. The other ram was more timid, but after several hesitations advanced also. When the first ram finished and went back up the trail 75 feet, the second went down to the water and drank long and without looking up.

About this time Sumner clicked the shutter of the camera and they jumped and then stared in his direction but continued drinking or standing still, whichever they happened to be doing. Next, Sumner sat upright in the blind (125 feet from the spring), with head and shoulders showing, and took motion pictures. The loud whirr of the motion picture camera made them start and walk about uneasily but they did not leave.

After both had drunk, they moved back up the trail a few feet, alternately staring at the blind and browsing from some bushes which proved to be *Atriplex confertifolia.* Once, one of the animals went up and locked horns gently with the other, and they stood that way for

a moment, without struggling or fighting—evidently not yet in the fighting stage of the reproductive cycle. At length they moved up the slope and out of sight.

About an hour later an old ewe was observed on the ridge between the upper and lower springs, 250 feet from the observer. Unlike the rams, she was not very timid. But by now the sun was right in the camera lens. Sumner crossed the wash in full view of her, but by that time she had drunk a good deal and when the camera was pointed at her from the shady side of the wash she had climbed warily up the slope and was seen no more.

It may be added that when the rams had drunk they evidently practically emptied the drinking pool (made of a basin of iron two feet across and about six inches deep), for it was still nearly empty when Sumner looked at it twenty minutes later.

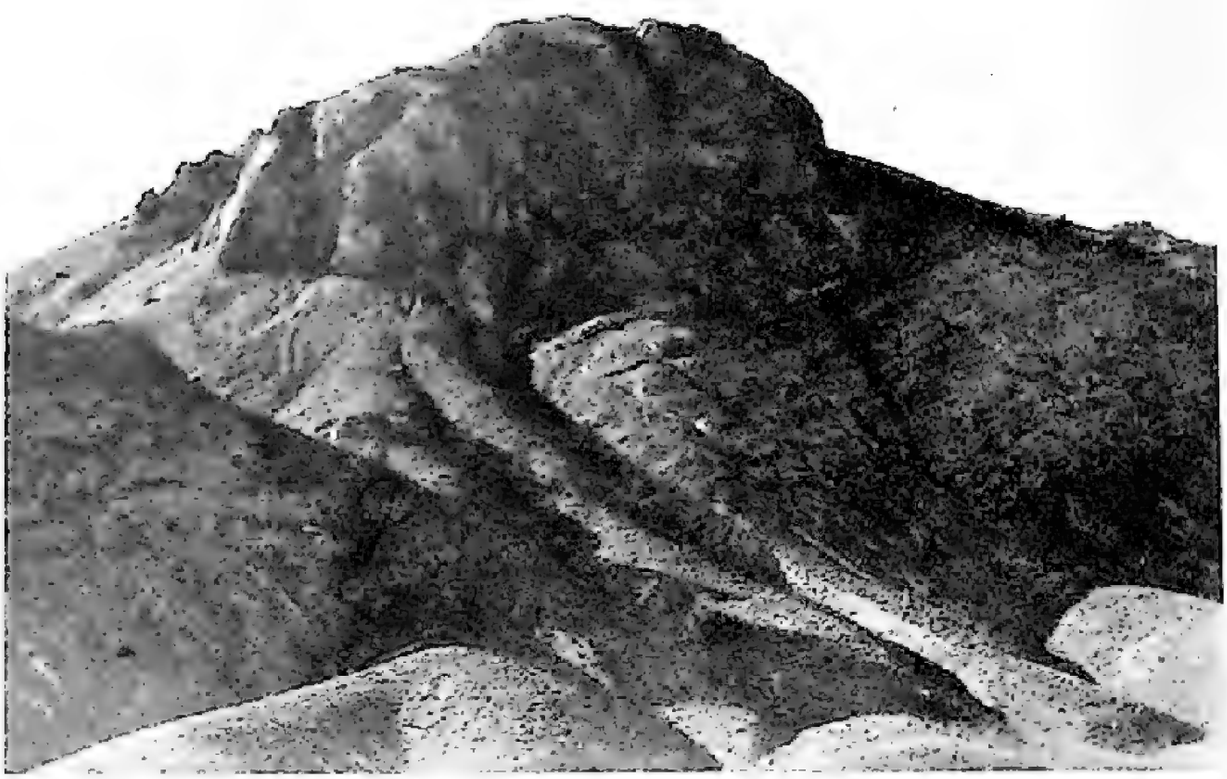


FIG. 11. Leaning Rock at sunrise. This massive rock on the western rim of Death Valley is one of the important wintering grounds of the bighorn. Natural "tanks" or cavities worn by water in the solid rock in a nearby canyon furnish the animals drinking water during dry seasons.

Droppings from one of the rams, examined twenty minutes after deposition, were firm and about the consistency of nearly dry putty, with the smooth, shiny exterior characteristic of old droppings. In other words, fresh droppings are nearly as dry and hard and are only slightly more shiny than droppings a day or so older. Evidently bighorn waste no more body water than they have to in this way.

Leaning Rock (8a)

In a natural "tank" in the shady, narrow canyon below Leaning Rock (see Fig. 41), we found that bighorn were pawing holes in the gravel to get fresh, cool water to drink. Fresh tracks of three bighorn —two adult ewes and one immature—were found in the bottom of the canyon and additional tracks were noted in the crags above.

Other fresh tracks indicated that a coyote had taken advantage of the opportunity and had dug a hole in the gravel in which to secure water. A careful search failed to reveal any evidence that the coyote had made any effort to capture or kill the sheep, water being evidently his main objective.

FIG. 42. A band of 14 bighorn carved in stone. These petroglyphs are believed to have been made by the Indians who formerly lived in the region and who lived largely on bighorn. It has been our experience that such petroglyphs serve as a dependable indication of the former abundance of sheep in a locality.

This spot has always been a favorite rendezvous for bighorn, according to Mr. Day, who has been a resident in the region for many years, and even before this the prehistoric Indian residents of the area had evidently visited the locality to secure water and probably also to secure bighorn for food. Many petroglyphs, or uncolored rock carvings, were found on the walls of this canyon. The native rock here consists of dark gray dolomite and in one place the Indians, by pounding on the rock, had created a series of images most of which were those of bighorn. In one small area, approximately eight by ten feet, a band

of 14 bighorn is depicted (see Fig. 42), besides many scattered individuals. Several lizards are also depicted. It has been our experience, where such petroglyphs of bighorn have been sculptured or carved by the Indians, that it is a relative index to the bighorn population in that area. The figures in this case all represented ewes and immature animals. None of the images that Dixon found in these petroglyphs had the tightly curled horns of the adult ram.

This box canyon we found to be exceedingly narrow in places—six to eight feet in width and from fifty to seventy feet deep. There were a number of dry waterfalls in the stream bed so that access was distinctly difficult. However, since the bottom of the canyon is rarely,

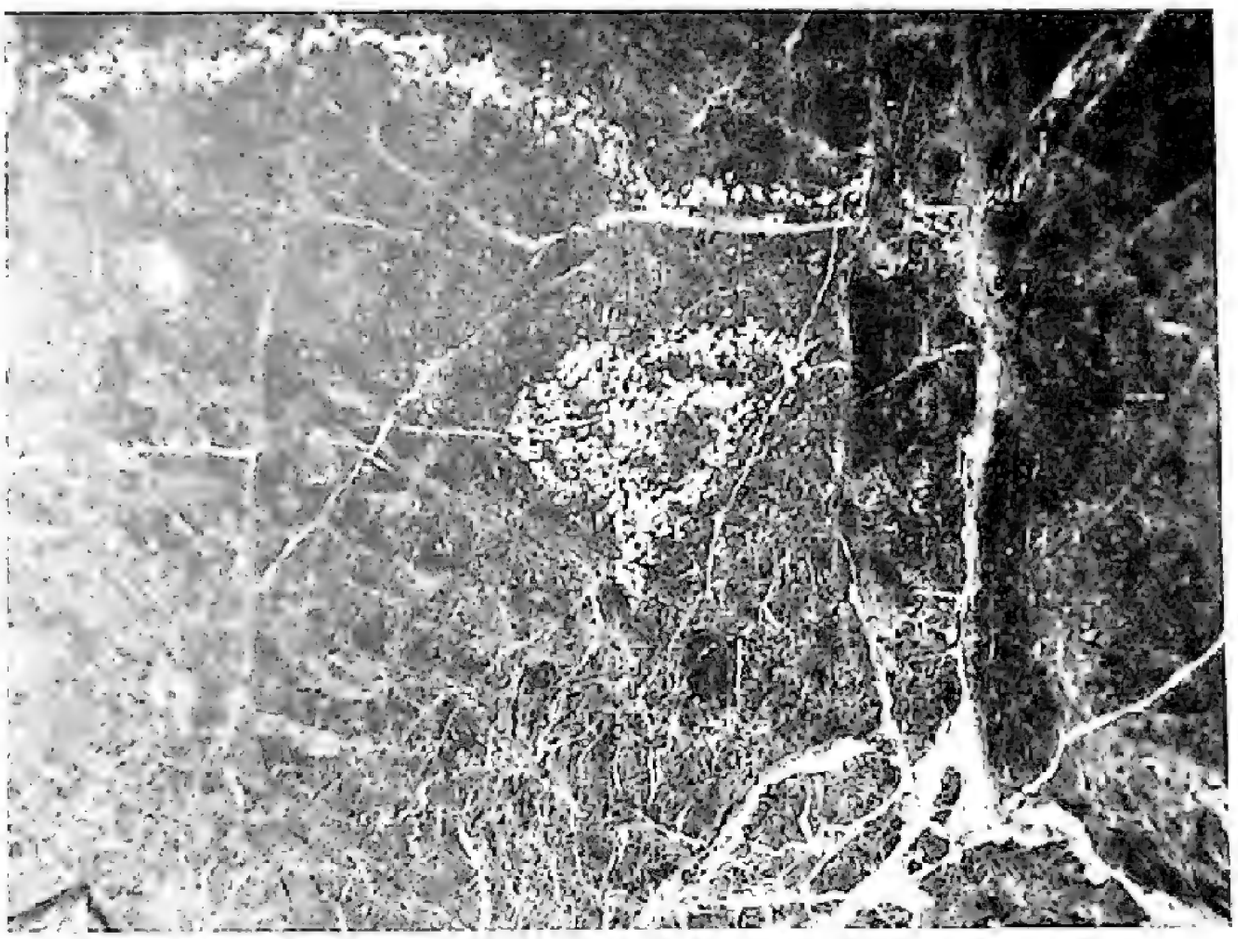


FIG. 43. Indian petroglyph or water sign. The long, white, horizontal line (top) above the curly sign pointing downward (center) means, "*dig here to get water.*" In Death Valley this knowledge may mean a matter of life or death to the traveler.

if ever, subjected to direct sunlight, the water in the natural tanks remains clear and cold and is readily available to any man or beast that will put forth the effort to do a little digging in the gravel that fills the solid rock basins in the bottom of the canyon. The gravel serves as a lid or cover to retard evaporation. Mr. Day told us that he had never yet failed to find water by digging in the gravel in the natural tanks in this canyon. This was the case even during the dry season when other water supplies failed.

In such critical localities, Mr. Day has found that there are usually Indian signs (see Fig. 43) which mean that water may be had at that spot by digging, as indicated by the downward pointing of the signs. Mr. Day has had a similar experience elsewhere in the Death Valley region. Another important water sign, used by the Indians before the coming of the white men in the Death Valley area, was a series of small white rocks. These rocks, usually elongated in form, were placed by the Indians on top of boulders which stand in a prominent position, and point in the direction in which a hidden spring, tank or other water supply is located. It is usually found that several white rocks of this nature were employed and that by careful scrutiny each succeeding water sign may be seen from the one previously visited. Because of the winding nature of the canyon, these water signs do not always constitute a direct line but, if followed, they faithfully lead the traveler to water, which in many cases may be a matter of life or death.

Dodd Springs (9)

We found that both of the Dodd Springs were over-run by a herd of 17 domestic cattle, which had trampled and polluted the water so that bighorn had ceased to drink there. Fresh tracks of two bighorn were found on the hill above the springs, however.

Grapevine Wash (9a)

In the Grapevine Wash below the Dodd Spring fresh tracks of two adult female bighorn were found at a spring in a narrow side canyon that had been little visited by domestic cattle.

Eagle Spring, Telescope Peak (10)

Eagle Spring was visited by Dixon and Gilman on September 26. No bighorn tracks or signs were found at this spring, which had been much used by five burros and three horses. This is a spring that had been developed and the water piped out into a natural rock basin as a CCC project. However, we found that burros and horses had trampled and filled the basin with rocks and polluted the water, with the result that no bighorn were at present watering there.

Birch Spring (10a)

Tuber Canyon was examined with binoculars by Gilman and Dixon on September 26, but no signs of bighorn trails or other use could be seen. Former Wildlife Technician A. E. Borell found no evidence of use by bighorn in January, 1935.

Upper Spring, Hanapaugh Canyon (11)

Hanapaugh Canyon, 9500 feet up the east face of Telescope Peak, was visited by Dixon and Gilman on September 25 and fresh tracks of one adult ram, three adult ewes and two immatures were found. Dixon examined closely the spring where considerable evidence of poaching was found in 1935, but a careful search failed to reveal any evidence of shooting. This is particularly gratifying since the bighorn have evidently come back to their original numbers in this area, judging from the number of bighorn that were found at this locality

in 1917 by Dixon. The lower spring in Hanapaugh Canyon was not visited in 1938 due to the complete washout of the truck trail in the lower part of the canyon.

CONCLUSIONS

In conclusion, three points are believed to be outstanding:

1. The natural water supply in the Death Valley area was found to be considerably greater in 1938 than it had been in 1935 and 1917.

2. There has been a slight but noticeable increase, believed to be from 10 to 25 per cent, in the number of bighorn found at the various critical areas visited. The evidence presented by fresh tracks, together with actual counts of individuals, gives a total of approximately 65 bighorn for the 21 areas visited. These areas represent, of course, only a limited portion of the total bighorn range in Death Valley National Monument. Moreover, it is almost certain that weather conditions prevented anything like a complete census, even in the areas covered by us.

3. Most encouraging of all was the fact that no evidence of poaching was found although particular scrutiny was made at Lemonade Spring and at Hanapaugh Canyon, where Dixon had found poaching serious in 1935.

CENSUS PLANS FOR 1939

The information gained as a result of the present study will be valuable chiefly as a basis for more intensive efforts next summer. The ground work has been laid and it is hoped that a really adequate picture of the status of the Death Valley bighorn can be presented in the near future.

Representatives of the California Division of Fish and Game have expressed their continued interest in the program and it is hoped that another cooperative attempt can be staged at a favorable time during the summer. Information gained from studying bighorn conditions is of importance in field studies which have been carried on by the Division of Fish and Game in areas adjacent to the Monument, including Grazing District No. 1.

Superintendent Goodwin has pointed out the great value of an airplane (particularly of the autogyro type) in searching for bighorn watering places by locating the green spots and converging trails from the air. The unsuccessful efforts of our party and of members of the Death Valley staff previous to this trip in locating Red Rock Springs presents a good example of the laborious, inefficient system of exploration necessary at present. According to Goodwin's computation, there are approximately 400 linear miles of mountains surrounding Death Valley—which is a further indication of the magnitude of locating watering places on foot.

DEER KILL RECORDS—A GUIDE TO MANAGEMENT OF DEER HUNTING [1]

By F. W. JOHNSON
United States Forest Service

Acknowledgments

The records of measurements and observations included in this discussion were obtained on the National Forests of California in 1935, 1936 and 1937.

Through the courtesy of the California Division of Fish and Game, an arrangement was made to employ the statistical section of their Fisheries Laboratory at Terminal Island. It was at this Laboratory that the 1936 series of records of over 11,000 deer killed was tabulated and recorded. This was made possible by Mr. Herbert C. Davis, Executive Officer, and Mr. Joseph S. Hunter, Chief of the Bureau of Game Conservation, Division of Fish and Game.

At this Laboratory both the director, Mr. W. L. Scofield, and Dr. Frances N. Clark offered encouragement in the use of statistical methods in this work as developed in fisheries research. Mr. G. H. Clark was helpful in suggesting methods of population studies as well as methods of correlating the group measurements. The specific task of tabulating and assembling group data for study was accomplished under the direction of Miss Geraldine Conner at Terminal Island, whom the author wishes to thank for the interest and time devoted to this work.

To those many game wardens, deer hunters, packers, plant quarantine inspectors, forest rangers, forest guards and CCC men who actually accomplished the task of making the field record of deer measurements, we extend our thanks. Mr. Paul Fair, United States Forest Service, photographed the deer heads used for illustration.

Introduction

The six races of deer are the only big game animals of importance to hunters in California. Five of these are found on the National Forests.[2] These large public forests are of importance as big game ranges because of their large contribution to the total kill and the fact that they are considered public shooting areas.

Approximately two-thirds of the 30,000 deer killed annually in this State are taken on the National Forests by the 110,000 hunters engaged in the sport. Deer are thus a widely distributed and widely

---

[1] Submitted for publication, February, 1939. This paper embodies the results of an investigation made by the United States Forest Service and presents recommendations based on this study.

[2] 1. Columbian black-tailed deer, *Odocoileus hemionus columbianus.*
2. Rocky Mountain mule deer, *Odocoileus hemionus hemionus.*
3. California mule deer, *Odocoileus hemionus californicus.*
4. Inyo mule deer, *Odocoileus hemionus inyoensis.*
5. Southern mule deer, *Odocoileus hemionus fuliginatus.* (See map of distribution, Fig. 44.)

used resource of the National Forests, and in the future the opportunity for public hunting will remain there as it is now.

The importance and value of the resource has long been recognized. For many years National Forest officers have enforced State game laws as voluntary wardens; systematic estimates of deer population have been made annually, as have recommendations on seasons and bag limits; studies and counts on the winter range have been made on important herds; range needed by deer has been made available by reducing permitted domestic stock; observations on breeding seasons, fawn crops, etc., have been recorded.

With the years, wide differences in quality of herds, quality of deer taken, suitability of legal seasons, and other factors have become evident as a result of studies conducted by the California Division of Fish and Game and the United States Forest Service, and as a result of hunter observation and experience.

These raised, without answering, major questions as to what was happening, what possibilities for improved deer management there may be, and what major trends were, on the National Forest areas.

The material reported here is the summary of the first two years' work leading to the objective of furnishing a factual background of unquestioned adequacy for the entire National Forest area—a background that might suggest or indicate needed changes in management and additional studies required to furnish a thoroughly sound basis for management of the kill factor.

The control of deer hunting through bag limits and seasons has been in effect for many years in California and other western states. The application of these measures has been an important phase in game administration. However, there has been little study made of the effectiveness of these measures, as *management measures*.

Recent trends in out-of-door activities, resulting in a rapidly increasing hunting effort in this State, have caused game administrators to question the effectiveness of seasons and bag limits to sustain both numbers and physical perfection of deer herds under heavy hunting pressure. It is generally accepted that the present system of freedom in selection of hunting areas by the hunters should be preserved, yet at the same time it is also necessary to preserve adequate virile breeding stock. Each year, for a period of two and one-half months, over a hundred thousand hunters take to the California forests. It would be strange indeed if this hunting effort does not affect the male deer population; if cropping the resource does not result in some change in its condition.

Tags returned by successful hunters during the past seven years to the California Division of Fish and Game show, that in general, the number of legal bucks killed has increased (California Division of Fish and Game, Biennial Report, 1934-1936). In certain localities, however, such as Trinity, Siskiyou and Glenn counties, the number has been reduced. Decreases here have been offset by increases in other areas such as Fresno, Modoc and Plumas counties.

Not only is there a dissimilarity in numbers in the annual deer crop in different forest areas, but there is an even greater variance in

its physical condition. It would, therefore, appear that some of the breeding herds may be in an unsatisfactory condition.

The problem of deer management on the National Forests of this State concerns quality of the deer crop and methods of harvesting this crop as well as providing an adequate forage supply for the number

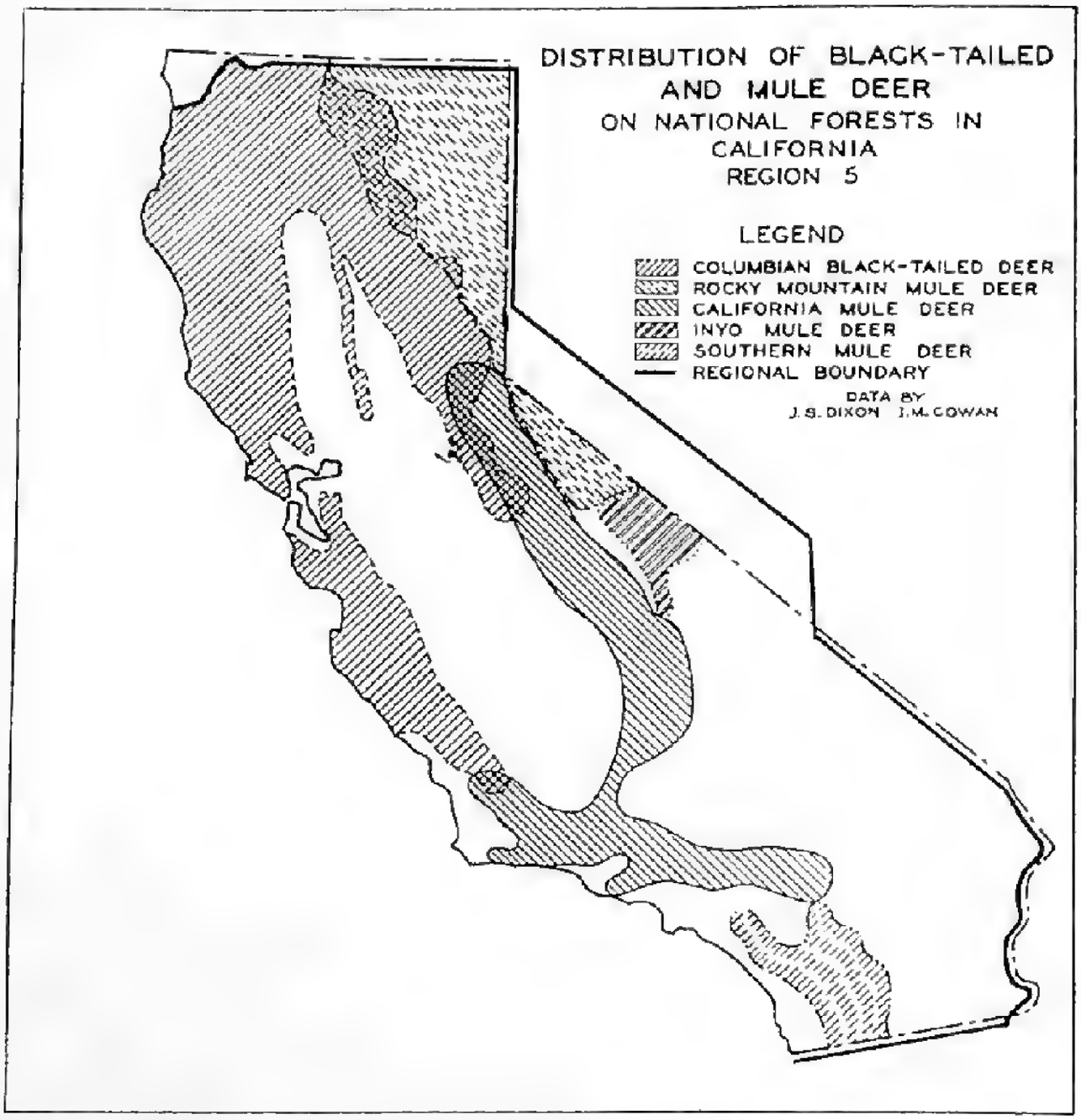


FIG. 44. Map of California showing distribution of the five races of deer which occur on the National Forests.

of deer that we now have. Except for a few areas, including portions of the Klamath, Trinity and Mono National Forests, a fairly good stocking of deer exists. The problems, therefore, seem to be to maintain present numbers of deer on the well-stocked forests, to maintain the quality of the breeding herds, and to obtain the proper sex ratio within these herds.

It is evident that a method is needed to give game managers accurate knowledge of the trends of the deer herds and the effect

of the hunting effort on the deer population. Some of the problems are: How may hunters be distributed naturally over the public shooting grounds so that freedom in hunting may result in optimum sport? How effective are our bag limits and seasons in preserving adequate numbers of prime sires for breeding stock? What methods may be

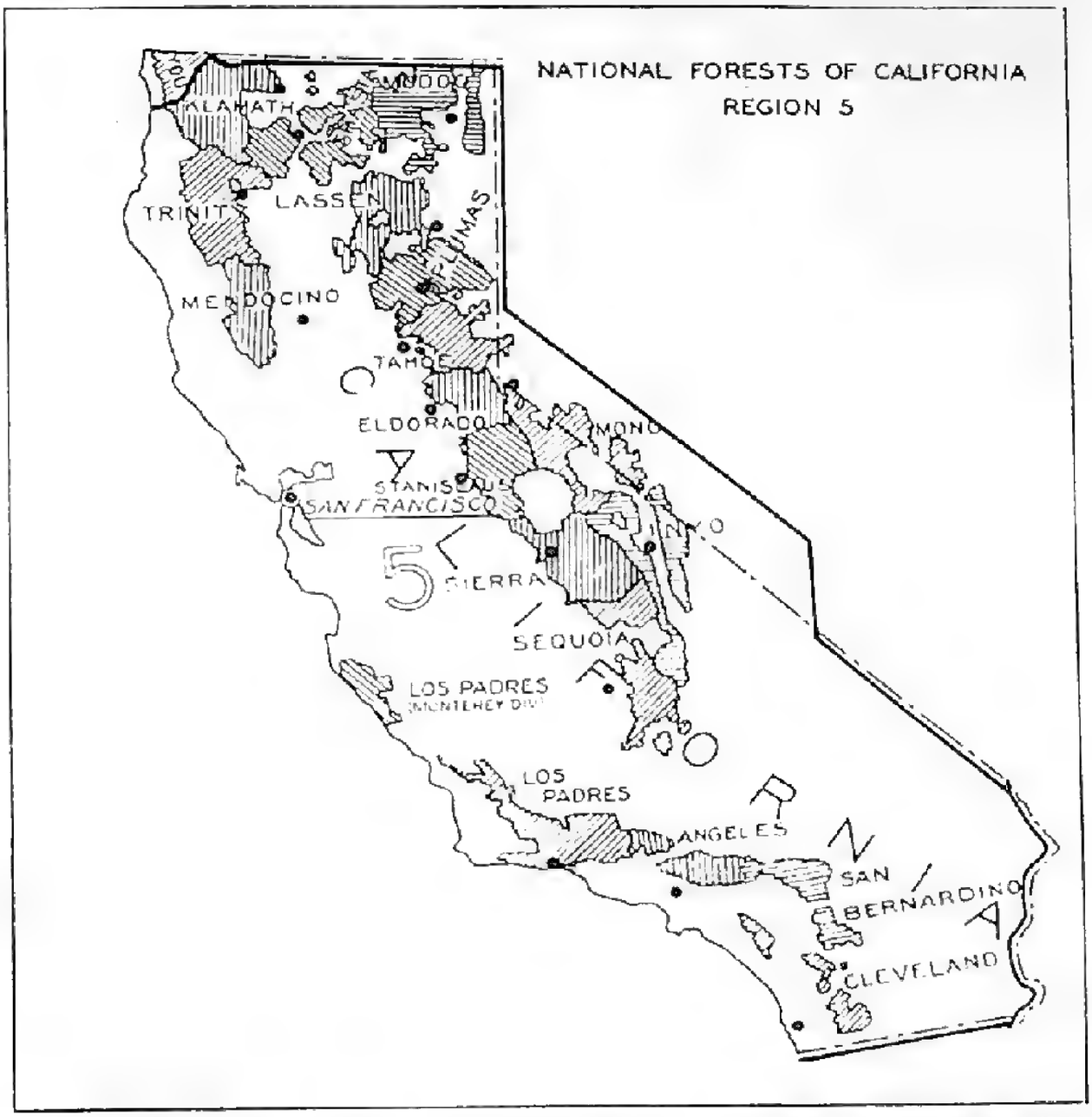


FIG. 45. Map of California, showing location of the 18 National Forests and the boundary of Region 5.

used in the field to determine trends of the deer crop for use in effecting sustained yield?[3]

Quality of Deer Crop MUST Be Sustained

In silvicultural practice, foresters think of sustained yield on timber lands in terms of the number of logs that can be grown per acre and the percentage of clear or upper grade logs. This study

[3] By sustained yield is meant the maximum of deer in good physical condition commensurate with the natural forage production of their summer and winter ranges.

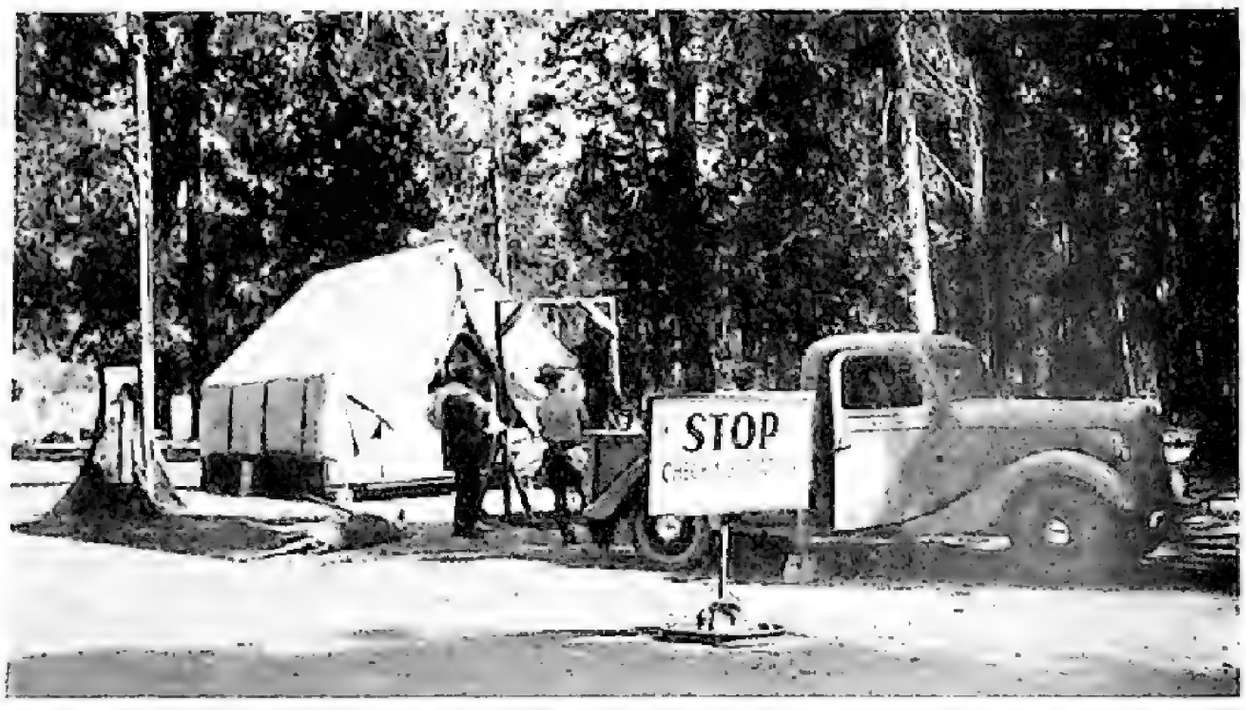


FIG. 46. Checking station on the Stanislaus National Forest.

applies the same thought to hunting areas; first, the number of deer that can be produced, and second, the *quality* of deer crop that can be harvested.

In the cropping process the forester selects mature trees, removes them and allows the smaller, vigorous trees to grow to maturity. This study deals with an annual crop taken from various age or size classes of deer. The information first needed is what size classes are being taken at the present time and what effect this has on the herd, not only in numbers but in physical condition as well. At the same time, consideration must be given the thousands of sportsmen who enjoy freedom in the open and who often return year after year to the same hunting grounds. This freedom is part of the American system where a man is free to track and make his kill. It should be preserved.

What are the qualities that are most desirable in a game animal along with physical attractiveness? They are alertness, gameness and ability to escape enemies. In addition they must be good rustlers and able to survive the trials of hard winters.

Geneticists believe that these valuable characteristics are inherited, that they are transmitted by sires that have proved they have these qualities by living to an age of maturity. They have no quarrel with those claiming that the progeny of an immature buck will not be as large as the progeny of a mature male deer. However, they do believe that breeding checks the growth of immature males; furthermore, that the increased use of immature sires is undesirable because they have not yet demonstrated that they possess the desirable qualities of a game animal.

The collection of deer kill records, particularly those applying to the physical condition of the crop and the hunting effort, is considered, therefore, a logical approach to the problem of maintaining or improving the quality of our deer herds.

FIG. 47 Hunter being registered into Los Padres National Forest.

The analysis of the records as brought out in this paper will be devoted to the quality of the male deer crop and deals only with the condition of the kill and its relation to hunting effort. Other factors including volume of forage, water, cover, predation and disease have an unknown effect on the male crop. As yet these factors have not all been isolated for thorough study. At this time they appear to be more closely related to numbers of deer than to quality.

Plan for Making Deer Kill Records Follows Methods Developed Through Study of Catch Records by California State Fisheries Laboratory

According to Frances N. Clark of the California State Fisheries Laboratory, the overfishing or excessive exploitation of a marine fishery off the coast of California is evidenced by the following indicators:

1. Fewer fish appearing in the catch per unit of fishing effort.

2. Reduction in size of fish taken or the appearance of a higher percentage of immature fish in the catch.

3. A movement of the fishing effort further afield to new sources of exploitation.

Records of the commercial fishes caught off the coast of California have been kept since 1916. In addition to totals, a measure of the catches for the various species, per unit of fishing effort, is obtained. Length and weight measurements are recorded for samples of the catch of the most important species. From the trends of size appearing in the sample of the catch, it is possible to determine the trend of the fishery resource.

It was hoped that similar principles could be applied to land forms. A trial was needed to determine if satisfactory and adequate records could be obtained by the Forest Service organization, and if statistical methods could be applied to show trends in the deer crop.

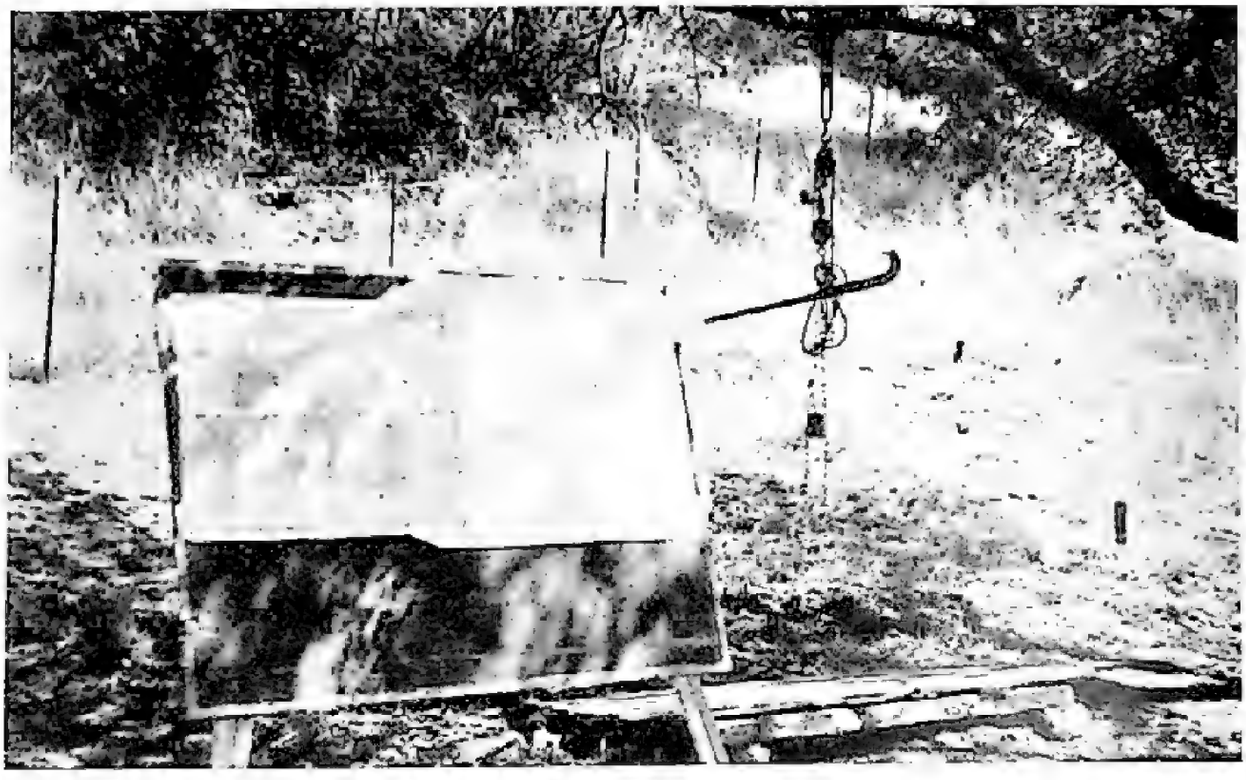


FIG. 48. Spot map mounted at checking station on Los Padres Forest, with platform, pulleys and steelyard scales.

Study Made of Physical Condition of Deer Crop in Relation to Seasons and Hunting Effort

During the open deer seasons of 1935 and 1936, a study of the deer crop was made on all of the eighteen National Forests in the California region. Antler measurements were made of over 18,000 deer taken by hunters. These measurements form the basis for this report. The methods used to obtain the deer kill measurements and methods of tabulating and analyzing the records are described below.

Advantage was taken of the Forest Service registration stations located at strategic points on the roads leading into the National Forests. In most places, these were the "bottlenecks" through which the returning hunters would bring their deer kill and where the records could be obtained. At one station, Hillcrest, on the Shasta Forest over 1100 deer were measured. Due to topography, some forests are accessible by many roads; here roving patrolmen secured the records in the hunters' camps. In addition, State Plant Quarantine officers obtained records of deer passing through their stations.

Adequacy of Sample

In deciding if the measurements were usable in judging the condition of the deer crop, it was necessary to know:

1. If an adequate random sample was obtained.

2. If this sample was a satisfactory cross-section of the male population.

Since over 50 per cent of the total kill was measured as to antler points, spread, and antler beam diameters, undoubtedly an adequate sample was obtained.

The comparison of "antler point" records in the sample with like records of the California Division of Fish and Game is strikingly similar. For comparative purposes, therefore, this sample of the kill appears to be satisfactory for use in lieu of total kill records. The inaccuracy in both cases lies in the fact that many of the larger and more alert bucks escape with the result they are not fully represented in the kill sample. A census of deer herds *during the rut* made on the Lassen and San Bernardino forests showed approximately 10 per cent more of the superior antler classes than are shown in the deer kill records.

The size of the weight sample varied by forests in accordance with the availability of the deer for measurement. In areas where long camping trips were the rule, deer were often dismembered before a checking station was reached. Where there were few overnight campers, the deer were carried out on fenders or running boards, permitting easy access for inspection and weighing.

In general it was found that it is difficult to secure an adequate random sample of actual weights and that we could not depend on weights alone, on all forests, to show size trends. Thus, it is necessary to develop a tool that may be used in lieu of actual weights, and which would, with a fair degree of accuracy, be suitable to show size trends. As a result, during 1936 over 3600 deer weights were secured, which form the basis of antler measurement correlation in the development of a field method in lieu of actual weights.

Type of Record

The data collected include records of five races of deer found within the eighteen National Forests of California, as developed by a study of this racial and geographic distribution by Cowan (1936). This description differs from Dixon's (1934) mainly in that Cowan includes the southern black-tailed deer as belonging to the Columbian black-tailed deer race, as indicated on the map. (See Fig. 44.)

The five races occur in a variety of climatic, food and cover conditions, from the humid redwood forests of the northwestern part of the State to the chaparral forests and desert slopes of southern California.

For each race the measurements and observations made were separated by forests, ranger districts and checking stations. Each checking station kept an individual record. Figure 49 shows a field record sheet made on the Sierra Forest in 1936. This record facilitates the study of the deer crop by small units.

SIERRA Nat'l Forest — Deer Kill Record - 1936 — NORTHFORK Ranger Dist.

Checking Station NORTHFORK — Checker Glyde Sturges (Name)

1 in. 2 in. 3 in. ← Scale in 1/10 inches. Use this for antler diameter records.

Date	Deer No.	Estimated Weight	Actual Weight	Antlers						Pelage		Condition				
				Spread	Points R	Points L	Diameter	Hard	Soft	Red	Blue	Fat	Good	Poor	Species	Remarks
9/27	65	155		21.0	4	3	1.2	x			x		x		CMD	
9/27	66	90		12.0	2	3	.7	x			x		x		"	
9/27	67	120		15.2	3	2	1.0	x			x		x		"	
9/28	68	100		12.0	2	2	.7	x			x		x		"	
9/29	69	170		23.0	5	5	1.3	x			x	x			"	
9/29	70	170		24.0	5	5	1.1	x			x	x			"	
9/29	71	90		8.2	2	2	1.0	x			x		x		"	
9/30	72	165		20.0	3	3	1.2	x			x	x			"	
10/3	73	95		13.0	2	2	.8	x		x			x		"	
10/4	74	90		14.0	2	2	.9	x			x	x			"	
10/4	75	100		7.0	2	2	7	x			x		x		"	
10/4	76	150	168	22.0	3	3	1.5	x			x	x			"	
10/4	77	120	129	10.0	3	3	.9	x			x		x		"	

FIG. 49. Sample deer kill record sheet.

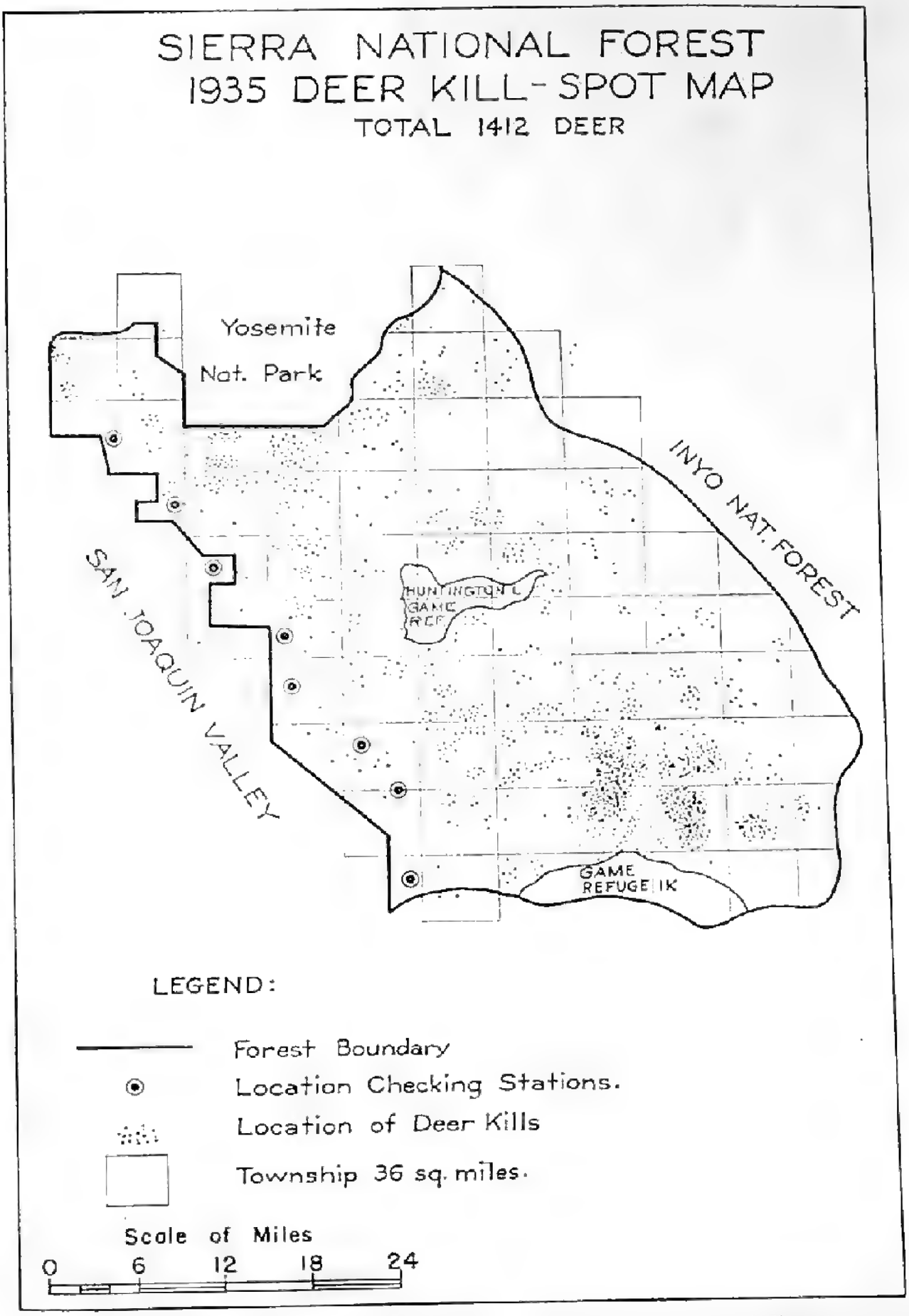


FIG. 50. Spot map of the 1935 deer kill on the Sierra National Forest.

FIG. 51. A deer-weighing rig with quarters for the crew. These stations operated 24 hours per day during the first 10 days of the season. California mule deer in the foreground. Stanislaus National Forest.

The measurements and observations recorded for each deer checked were:

1. **Estimated Weights (Dressed).** Where deer could not be weighed, the weight was estimated. Estimated weights were found to be both above and below actual weights and were more accurate than anticipated. However, only actual weights were used in the correlations made in this study. No effort has yet been made to determine the accuracy and value of estimated weights.

2. **Actual Weights (Dressed).** The actual weight measurements were made on steelyard scales and are accurate within one pound. Dressed weights were made with head, hide and feet attached.

3. **Spread.** The antler spread was measured with a rule at the greatest width. This measurement was recorded in inches and tenths of inches.

4. **Antler Points.** The number of tines occurring on each beam, not including brow tines, was recorded.

5. **Diameter of Beam.** The antler beam diameter measurements were made with calipers, taking the average diameter one inch above the burr at the base of the beam. This measurement was recorded in tenths of inches.

6. **Condition of Antlers.** Antlers in velvet or hardened were recorded.

7. **Condition of Pelage.** Pelage in red summer or blue fall coat was recorded.

8. **Condition of Flesh.** Flesh conditions were judged and recorded as being fat, good or poor. These data have not as yet been assembled to determine their value.

9. **Race.** The race of deer occurring on the area was recorded. Where two races occur in the same area, tail markings were used to identify the race.

10. **Remarks.** Under this heading special items were recorded such as apparent age of deer, condition of teeth, neck swelling, etc.

11. **Spot Maps.** The place where each deer was killed was marked on a map by the checker. The completed spot maps are of great interest. They delineate areas where deer are killed—areas that are natural game range. Figure 50 shows the 1935 kill for the Sierra National Forest. There are 1412 kill locations spotted on this map, representing 95 per cent of the total kill. This is very useful in a study of hunting effort and the relationship of the kill to accessibility, cover types, refuges, etc. They assist in the proper location of checking stations and indicate areas where management of hunting effort may be most effectively used.

12. **Hunting Effort.** On some of the forests a record was kept of the number of hunters entering and leaving each day. This gave a record of hunting effort by man-days.

FIG. 52. A deer-weighing rig attached to end of light truck for use of roving patrolmen. This deer was killed on the San Jacinto District of the San Bernardino National Forest. It is a southern mule deer having two small tines on one side and a straight beam or "spike" on the other.

The records of condition of antlers, pelage and flesh, particularly the latter, were a matter of judgment but represent the condition as observed by the recorder. Special emphasis was made on this phase in the training of the men, in order to secure uniformity of observation.

Analysis of Records

Through cooperative arrangements with the California Division of Fish and Game, the 1936 kill records were summarized at the Terminal Island Laboratory. Here the complete record of each deer was punched on a card for tabulating on Hollerith machines. This included a code number for each forest and checking station; also the date, weight, antler spread, antler beam diameter, pelage and antler condition records, by species. Figure 53 shows a sample card.

Through the use of this system, the study of the deer crop in relation to seasons and hunting effort can be made on small geographical or

ecological units. Parts of one ranger district may be compared with another, or comparisons made between forests having the same race of deer occupying very different environmental conditions. In fact, by using the punch card method, the data may be subjected to an extremely wide variety of comparisons.

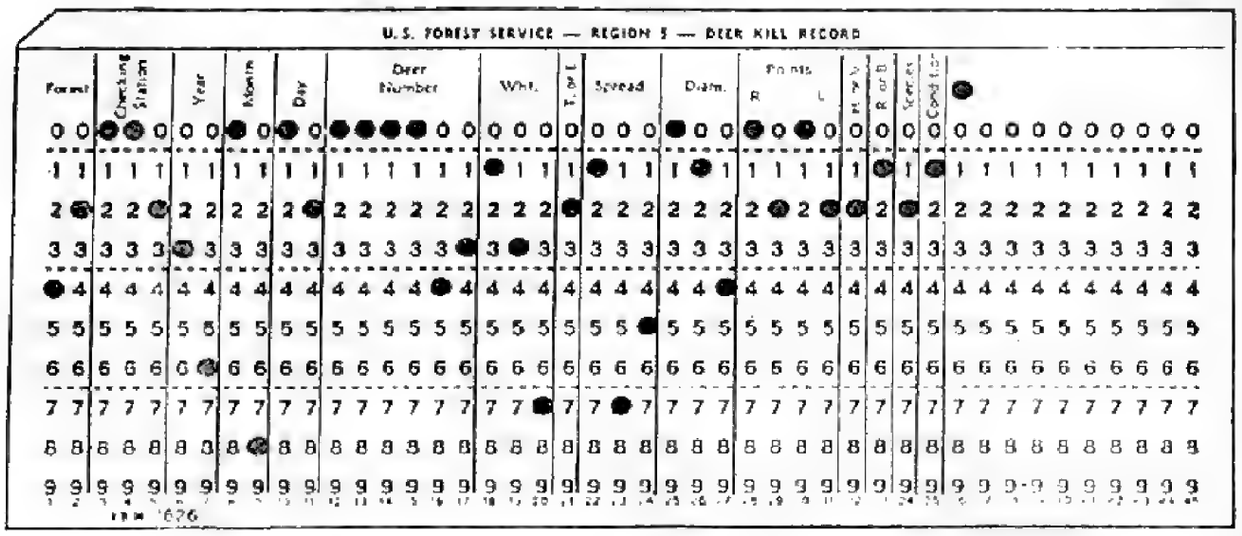


Fig. 53. Sample punch card as used in the study of deer kills.

Analysis of Kill Records Made by Antler Points, Antler Spread, Antler Beam Diameter and Weight Measurements to Establish Size Trends and Size Condition of Deer Crop

For the purpose of analysis, the weight and antler measurements were separated first by races, then by forests on which these races occur. This is, of course, necessary in the study of any animal population (Babcock and Clausen, 1927).

The following weight and antler classes were set up for compilation:

1. **Antler Point Classes.** In this work a modified system of point classes was used which separated the odd and decadent classes from the normal classes.

a. *Normal Classes.* This class included heads with the same or successional number of points on each beam. For instance, a 4 x 4 head has four points on each beam. These were arranged in successional order as follows: 1 x 2, 2 x 2, 2 x 3, 3 x 3, 3 x 4, 4 x 4, 4 x 5, 5 x 5, 5 x 6, and 6 x 6 plus.

b. *Odd Classes.* This class included deer with unusual antlers, for instance, a head having two points on one beam and five on another, or a 2 x 5 head. This separation was made because many of these "odd" heads are found on old deer and are believed to be the first stage of decadence.

c. *Pacific Buck or Decadent Classes* were those having 1 x 2, 2 x 2, or 2 x 3 heads of large spread and heavy beams. These are the decadent bucks described by Dixon (1934). (See Fig. 71.)

2. **Weight Classes (Dressed Weights).** The weight classes for each race were set up in 10-pound classes, excepting the first group which included deer weighing less than 80 pounds, and the last comprising deer weighing 210 pounds and over. (On completion of the analysis, it has been found that the smaller group probably should be broken down into 10-pound classes, starting with a 50-59-pound class.)

3. **Beam Diameter Classes.** The diameter classes were established by using 2/10-inch for each group except the first class which includes all beam diameters measuring less than 0.7 inches.

4. **Spread Classes.** The spread classes were divided into 2-inch groups except the largest in which is included those 32 inches and over.

Group Correlation Used to Determine Which Measurement Most Indicative of Size or Perfection

The "diameter class" and "spread class" groups as well as "antler point" groups were correlated with the actual weight group records by races and by forests to determine which had the highest indicative value.

As stated previously, there is need for a simple field method by which size classes and eventually, it is hoped, age classes of the deer crop may be known at the end of each season.

In this study weight is used as the criterion of size or perfection. Thus the correlation of antler point, antler beam diameter, and antler spread classes with known weights should show mathematically which one of these measurements is most indicative of size. If the correlation rating is sufficiently high, this should give a method to allow *trends in weight* of the crop to be measured by trends in antler size occurring in the kill samples.

Kill records of the crop of deer taken on the Allegheny National Forest in Pennsylvania (Park, 1936) show that deer overpopulation and the resultant reduced food supply has resulted in a reduction of 35 per cent both in weight and antler growth.

Antler growth undoubtedly depends upon an adequate supply of forage. It is well known that due to climatic conditions the forage supply varies annually on the game ranges in the National Forests. Far more forage than the deer can utilize is generally produced on the summer ranges. The volume available for deer is great enough to offset variations due to climatic changes. Thus, we believe the antler growth of deer in this region is normal and is not affected by any lack of forage. In addition, the deer measurements used in the correlation work were separated by deer races and areas of uniform habitat.

The method of group correlation used is that advocated by Davenport and Ekas (1936, pp. 79-81).

The formula for the calculation of the correlation coefficient r from grouped data and using assumed means is as follows:

$$r_{xy} = \frac{\sum fx^1y^1 - \frac{(\Sigma fx^1)(\Sigma fy^1)}{N}}{\sqrt{\sum f(x^1)^2 - \frac{(\Sigma fx^1)^2}{N}} \sqrt{\sum f(y^1)^2 - \frac{(\Sigma fy^1)^2}{N}}}$$

TABLE 1

Weight-Antler Beam Diameter Relationship of 500 Rocky Mountain Mule Deer, 1936

$r = .80$

Antler diameter classes	Weight classes (dressed), in 10-pound groups															Total
	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200-209	210+	
Inches																
.4- .7	8	10	14	12	6	4	2	-----	-----	-----	1	-----	-----	-----	-----	57
.8- .9	4	10	8	16	18	6	7	8	4	4	4	1	-----	-----	-----	90
1.0-1.1	-----	1	4	10	9	22	22	18	12	11	7	3	1	2	2	124
1.2-1.3	-----	1	5	2	3	6	14	11	11	8	9	12	3	5	0	90
1.4-1.5	-----	-----	-----	2	2	2	11	5	2	5	4	2	7	5	1	48
1.6-1.7	-----	-----	-----	-----	-----	1	-----	2	1	4	4	5	4	5	8	34
1.8-1.9	-----	-----	-----	-----	-----	-----	-----	-----	2	5	6	1	3	2	3	22
2.0-2.1	-----	-----	-----	-----	-----	-----	-----	-----	1	1	1	2	3	2	5	15
2.2-2.3	-----	-----	-----	-----	-----	-----	-----	-----	1	-----	-----	-----	-----	-----	1	2
2.4-2.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1	1	2	1	2	7
2.6-2.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1	1
2.8-2.9	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0
3.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1	1
Total.	12	22	31	42	38	41	56	44	34	38	37	27	23	22	33	500

A series of 18 sets of correlations was completed. This included correlations of antler point, antler spread and antler beam diameter measurements with actual weights, for the five races of deer within the National Forests of this region. For purpose of illustration, the kill records of Columbian black-tailed deer on the Mendocino, Klamath, Trinity and Shasta forests and the Monterey Division of Los Padres Forest were used to represent this race; the kill records of the Rocky Mountain mule deer on the Lassen, Modoc, Shasta, Mono and Plumas forests and the east side of the Tahoe Forest were used to represent this race; the kill records of California mule deer on the Sierra, Stanislaus, Sequoia, Eldorado and Mono forests to represent this race in the Sierra Nevada; the kill records of the Angeles, Los Padres and San Bernardino forests to represent the chaparral-type California mule deer; the Inyo Forest kill records to represent the Inyo mule deer; and the kill records of the Cleveland Forest to represent the southern mule deer. These forest groups were selected because they cover the geographic distribution of the respective deer races and are natural

ecological units. The California mule deer were separated into Sierra Nevada and chaparral forest groups for analysis because of the marked difference in habitat in these units.

The results of correlating the weight and antler measurement groups are presented in table 2.

The rating of correlation coefficient values is as follows:

.0 to .6 equals poor
.6 to .8 equals fair
.8 to .93 equals good
.93 to .98 equals high—very high
1.0 equals perfect

Table 2

CORRELATION RATINGS OF WEIGHT AND ANTLER MEASUREMENT GROUPS

Forest groups	Race	Correlation ratings			
		Antler points-weight	Antler spread-weight	Antler-beam diameter-weight	Number of deer used for each race
Klamath, Trinity, Shasta, Mendocino, Monterey Division of Los Padres	Columbian Black-tailed Deer	.38	.68	.70	314
Modoc, Lassen, Shasta, Plumas, Tahoe, Mono	Rocky Mountain Mule Deer	.61	.71	.80	500
El Dorado, Stanislaus, Sierra, Sequoia, Mono	(Sierra Nevada) California Mule Deer	.60	.78	.78	473
Angeles, Los Padres, San Bernardino	(Chaparral Forests) California Mule Deer	.57	.69	.71	470
Inyo	Inyo Mule Deer	.61	.90	.77	47
Cleveland	Southern Mule Deer	.64	.61	.78	64

Antler Beam Diameter Measurement Most Accurate Indicator of Size in Lieu of Actual Weights

The results of correlation of these measurements with known dressed weights of deer show that the antler diameter measurements are the most constant and have the highest average rating.

For the Inyo mule deer a high correlation rating is had between antler spread and weight. However, the sample used for this race is small and additional measurements are apparently needed before the figure can be accepted.

For all of these deer races, the number of antler points is the least reliable as a size indicator. This is well illustrated in comparing the last 3 x 3 heads shown in the table in figure 49. Both are "three-pointers" but one is much heavier and obviously much older than the other.

These results are consistent with the work of Cahalane (1932) who found that antler beam diameter measurements give best results in determining age-classes of Michigan white-tailed deer. These results differ in that his study was made in relation to known ages rather than actual weights.

Cahalane states the results of his antler beam diameter-age relationship study as follows. "Although not as clear cut as is desirable, beam diameter is a useful index to the age of Michigan whitetail deer, giving sufficient distinction between individuals of several age classes to make worthwhile its employment for field purposes."

Cahalane's findings strengthen the work described in this article and the use of antler beam diameter measurements as a field tool in judging size and age classes in the deer kill.

In this regard the following is quoted from Cowan (1936), "Age variation in deer is not pronounced after the fourth or fifth year. Its manifestations are most apparent in body size, color of the head of males, antler rugosity and certain cranial features. In the absence of sufficient data not much can be said concerning the increase in body size and weight with advance in age, save that such does take place."

Quality and Size of Deer Killed Vary by Forest Areas

The 1936 kill records show marked differences in the quality of the deer crops. These differences occur within races between areas of similar game range conditions as well as between areas with quite different game range conditions.

The outstanding difference in quality of the deer crops is found on the Mendocino and Klamath national forests. These have similar range conditions and the same race of deer, Columbian black-tail. Figure 54 shows graphically a comparison of the 1936 crop on these two forests.

The four sections of the graph show the percentages of antler point classes in the total crop, and the same for antler spread, antler beam diameter and weight classes.

In the antler point classes, the Mendocino shows a high percentage of small forked horn or 1x2 and 2x2 heads which total approximately 60 per cent of the crop. The Klamath Forest record shows that the combined 1x2 and 2x2 classes comprise only 24 per cent of the total crop, while the highest number in any antler class is in the four-pointer group, which alone totals approximately 25 per cent of the total kill.

In the weight classes the graph shows that the superior weights of 140 pounds or better are well represented in the Klamath Forest kill, but very poorly in the Mendocino kill, and the weight classes above 160 pounds are not at all represented in the latter forest.

The spread classes show that the largest percentage of deer killed on the Mendocino have spreads between 10 and 11 inches, and superior spreads of 22 inches and over are not represented in the records. The Klamath record shows the highest percentage of spread measurements in the 14- and 15-inch class, and all spread classes are represented. Spread measurements between 22 and 27 inches may be considered superior since several heads of 28-inch spreads are recorded in the "list of record heads for Columbian black-tailed deer" by the American Society of Heads and Horns.

The antler beam diameter classes, which have been found the best diagnostic criterion in lieu of actual weights, show a decided superiority of the crop on the Klamath Forest.

By using these four methods of judging the quality of these deer crops, it is readily seen that a remarkable difference in quality exists when the same measuring sticks are used.

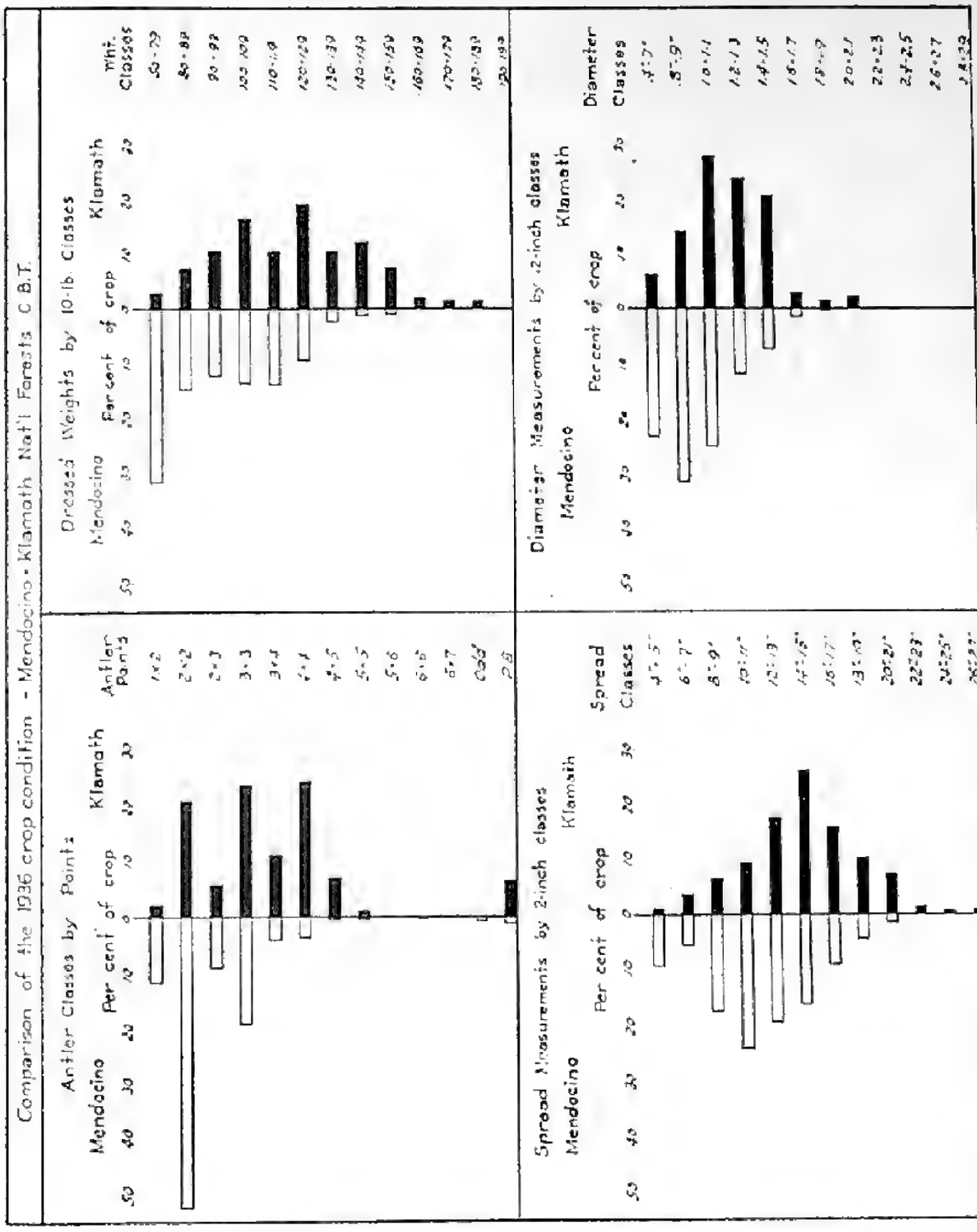


Fig. 54. Comparison of Columbian black-tailed deer crop condition on Mendocino and Klamath National Forests in 1936.

On the Klamath Forest there were fewer hunters and the hunting effort was only one-third that on the Mendocino. The relative success per hunter was far higher and the *total number* of superior animals bagged was notably above the number of like animals taken on the Mendocino. From this we can logically conclude that a much larger proportion of superior deer was available on the Klamath Forest than exists on the Mendocino.

Comparison of the 1936 crop conditions found on the Angeles and Sierra national forests is a comparison of the same race of deer (California mule deer) found in different habitats. The Angeles Forest is principally a chaparral forest while the Sierra is mixed conifer.

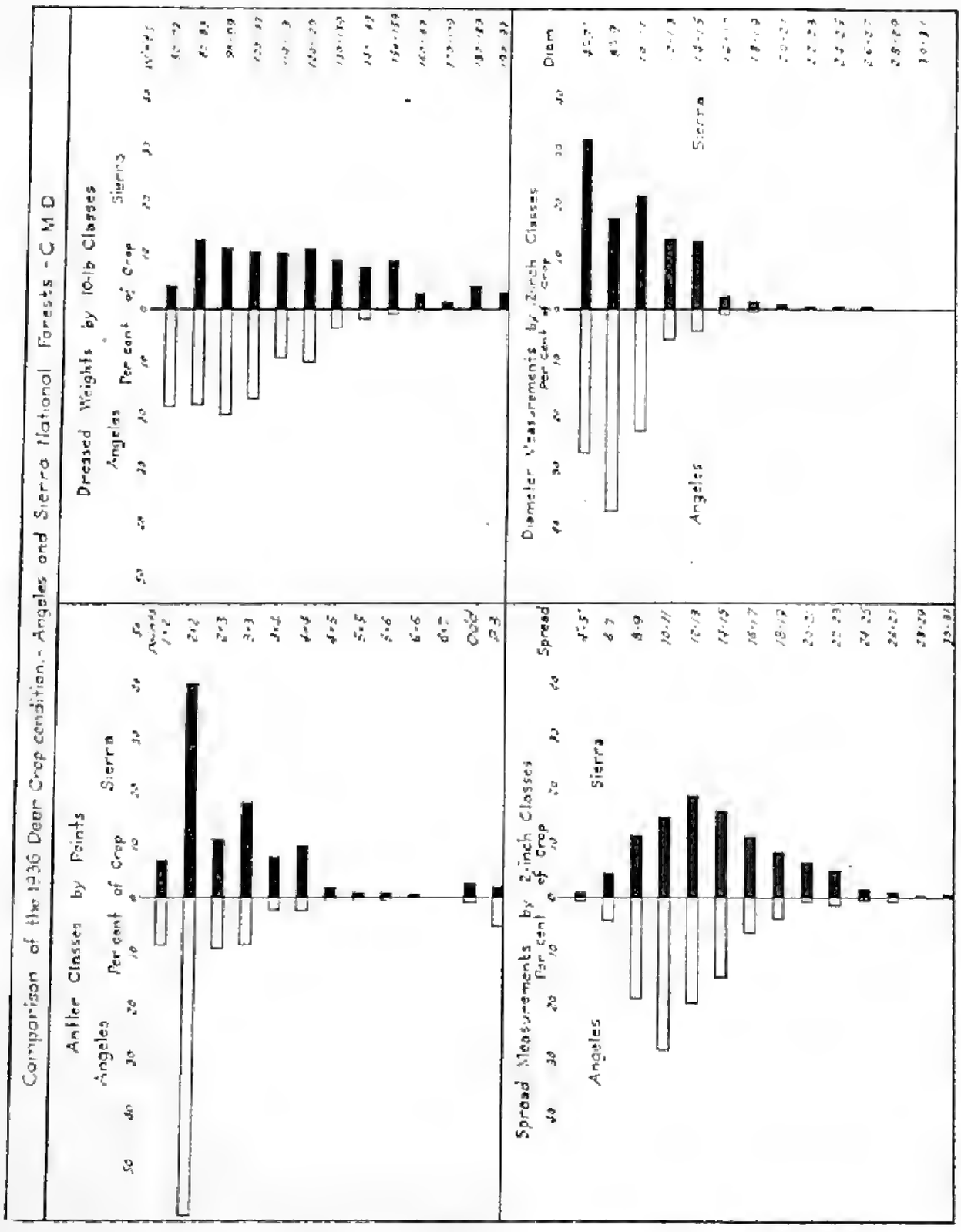


Fig. 55. Comparison of California mule deer crop condition on Angeles and Sierra National Forests in 1936.

In figure 55, the comparison of crop conditions in the 1936 deer kill records of the Sierra and Angeles forests is presented in graphic form.

The superiority of the California mule deer of the Sierra Forest is pronounced in the antler point, antler spread, antler beam diameter and weight classes. The crop of deer on the Angeles Forest was taken by approximately 11,000 hunters on an area of approximately 450,000 acres. The crop on the Sierra Forest was taken by approximately 7,000 hunters on an area of 1,500,000 acres. It would seem that a larger hunting effort expended on a smaller area should be able to secure superior deer if they were available. From this we may also logically conclude that fewer superior deer, on an area basis, were available on the Angeles Forest than on the Sierra Forest. Studies of herd composition within the large refuge on the Angeles Forest indicate an inherent difference in quality of males on the two forests, due (partially) to quality of forage, racial characteristics or other factors besides hunting effort.

The Mendocino-Klamath and Sierra-Angeles deer crop comparisons are used to illustrate the wide differences that exist in crop conditions. These conditions are found to a lesser degree on other national forests within the same deer races.

Quality and Size of Deer Killed Is Inversely Proportional to the Hunting Effort

When the hunting effort on each forest is compared to the size and quality of the kill, the records show that the following conditions exist where areas are subjected to heavy hunting pressure:

1. The deer crop is inferior in quality of antlers.
2. The deer crop is inferior in size.
3. The deer crop consists of a high percentage of immature males.

The difference in size and quality has been discussed in the previous section. The difference in hunting effort and the concentration of hunting on forests are illustrated in figures 56 to 60. These figures show the number of deer measured on each day of the hunting season. Where large peaks of hunting effort occur, as on the Mendocino and Angeles forests, the crop conditions found are inferior. The analysis of hunting effort on other forests, in relation to condition, shows that quality and size of deer taken diminish as the hunting effort increases.

It appears that the major factor in the *lack of superior males* in the crop is due to the *taking of so many immature males*. There is greatly reduced opportunity for proper herd replacement. The effect of heavy cropping of immature males, combined with natural losses, over a period of years results in the production of few, if any, superior animals.

Condition of Antlers and Pelage in Relation to Seasons

In figures 56 to 60 are shown the number of deer measured, by five-day periods, during the 1936 season on the national forests, the number of deer that had antlers in velvet and the number of deer that were in red summer pelage. The striking differences found in crop quality might be discounted on grounds of forage supply, soil

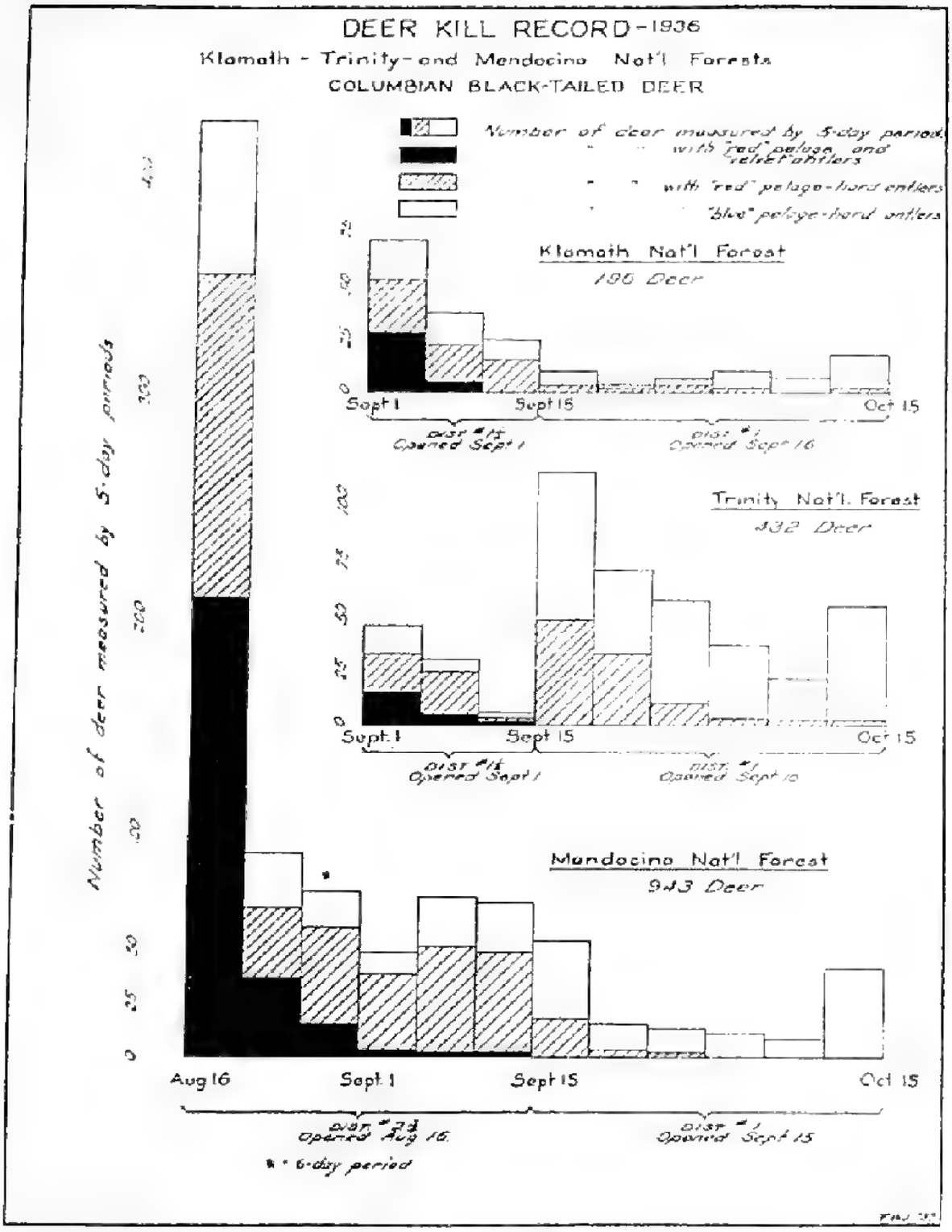


FIG. 56. Number and condition of Columbian black-tailed deer measured on Klamath, Trinity and Mendocino National Forests, by five-day periods, 1936.

composition or climatic conditions. Due to the correlation of poor crop quality with heavy hunting effort within areas of similar environmental conditions, it is definitely indicated that variance of deer crop quality within the deer races studied is due to hunting effort.

The rating of animals in respect to prime condition for taking was based upon the premise that the word *prime* should apply to bucks or deer in the same manner that it applies to the prime carcass

of a domestic animal—that the animal should be fat. It is generally agreed that this condition is evidenced by the blue winter coat after shedding of the red summer pelage.

The study showed that this condition followed well after the horns had been rubbed of velvet. The blue coat, therefore, is a better indicator of prime condition than the attainment of hard antlers. Therefore, the taking of deer in the velvet is a definite indicator of too early a season.

The study of the weight-season relationship is tabulated below. (See Table 3.) This study compares similar antler beam diameter classes. Equal numbers of each antler class were not available for use. The deer weights and measurements used in table 3 were selected at random from the field record sheets, which permitted separation by dates.

TABLE 3

MENDOCINO DEER KILL RECORDS, 1937

Comparison of Weight-Pelage and Antler Conditions of 102 Columbian Black-tailed Deer in 1937

Number of deer	Antler beam diameter	Total dressed weights	Average dressed weights	Pelage		Antlers	
				Red	Blue	Velvet	Hard
(1) Antler Beam Diameters, 0.6 in. to 0.9 in.							
25 deer killed between August 1 and August 16							
1 9 5 10	0.6 in. 0.7 in. 0.8 in. 0.9 in.	1,814 lbs.	72 lbs.	25	0	25	0
25 deer killed between September 1 and September 30							
3 4 6 12	0.6 in. 0.7 in. 0.8 in. 0.9 in.	2,176 lbs.	87 lbs.	6	19	1	24
Average difference in weight in favor of September 1 to September 30=15 lbs.							
(2) Antler Beam Diameters, 1.0 in., 1.1 in. and 1.2 in.							
20 deer killed between August 1 and August 16							
8 8 4	1.0 in. 1.1 in. 1.2 in.	1,891 lbs.	95 lbs.	20	0	20	0
20 deer killed between September 1 and September 30							
9 3 8	1.0 in. 1.1 in. 1.2 in.	2,089 lbs.	104 lbs.	7	13	0	20
Average difference in weight in favor of September 1 to September 30=9 lbs.							

TABLE 3—Continued

(3) Antler Beam Diameters, 1.3 in. to 1.4 in.

6 deer killed between August 1 and August 16

4 2	1.3 in. 1.4 in.	652 lbs.	109 lbs.	6	0	6	0

6 deer killed between September 1 and September 30

4 2	1.3 in. 1.4 in.	733 lbs.	122 lbs.	1	5	0	6

Average difference in weight in favor of September 1 to September 30=13 lbs.

As seen from table 3, the deer of the same antler beam diameter classes killed between September 1 and September 30 are from 9 to 15 pounds heavier than those killed between August 1 and August 16. All of the 51 deer killed between August 1 and August 16 had red coats and velvet antlers.

Of the 51 heavier deer killed after September 1, 14 had red coats and 37 had blue coats; 1 had antlers in velvet and 50 had hardened antlers.

Thus, preliminary studies show that these deer of practically the same size or age classes make better venison and better trophies if taken later in the season.

Figure 56 describes the condition of the deer as to antler and pelage during the three open seasons affecting the Columbian black-tailed deer on the Klamath, Mendocino and Trinity national forests.

The season on the Mendocino Forest in 1936 was opened August 16. At this date, it is indicated a large percentage of the deer had red coats and velvet antlers. It will be noted that the Columbian black-tailed deer found on these three forests become prime at practically the same time. The last date on which observations of deer having red summer coats were recorded are practically the same on each forest. The graph shows that the last dates on which velvet antlers were reported on the Mendocino were nearly the same days as the last record of velvet antlers on the Klamath and Trinity forests.

The graph shows that if condition of readiness is desirable when opening dates are established, the season on the Klamath, Trinity and Mendocino forests should open at the same time and after the date of September 15, and not much before October 1.

During the 1937 session the California State Legislature established August 1 as the opening date in District $2\frac{3}{4}$. This district includes the main portion of the Mendocino National Forest. It is evident that this can only result in a larger proportion of the crop being in poor condition.

The three districts affecting the Rocky Mountain mule deer all open on the same date, September 16. The record shows that on this date the deer are in satisfactory condition.

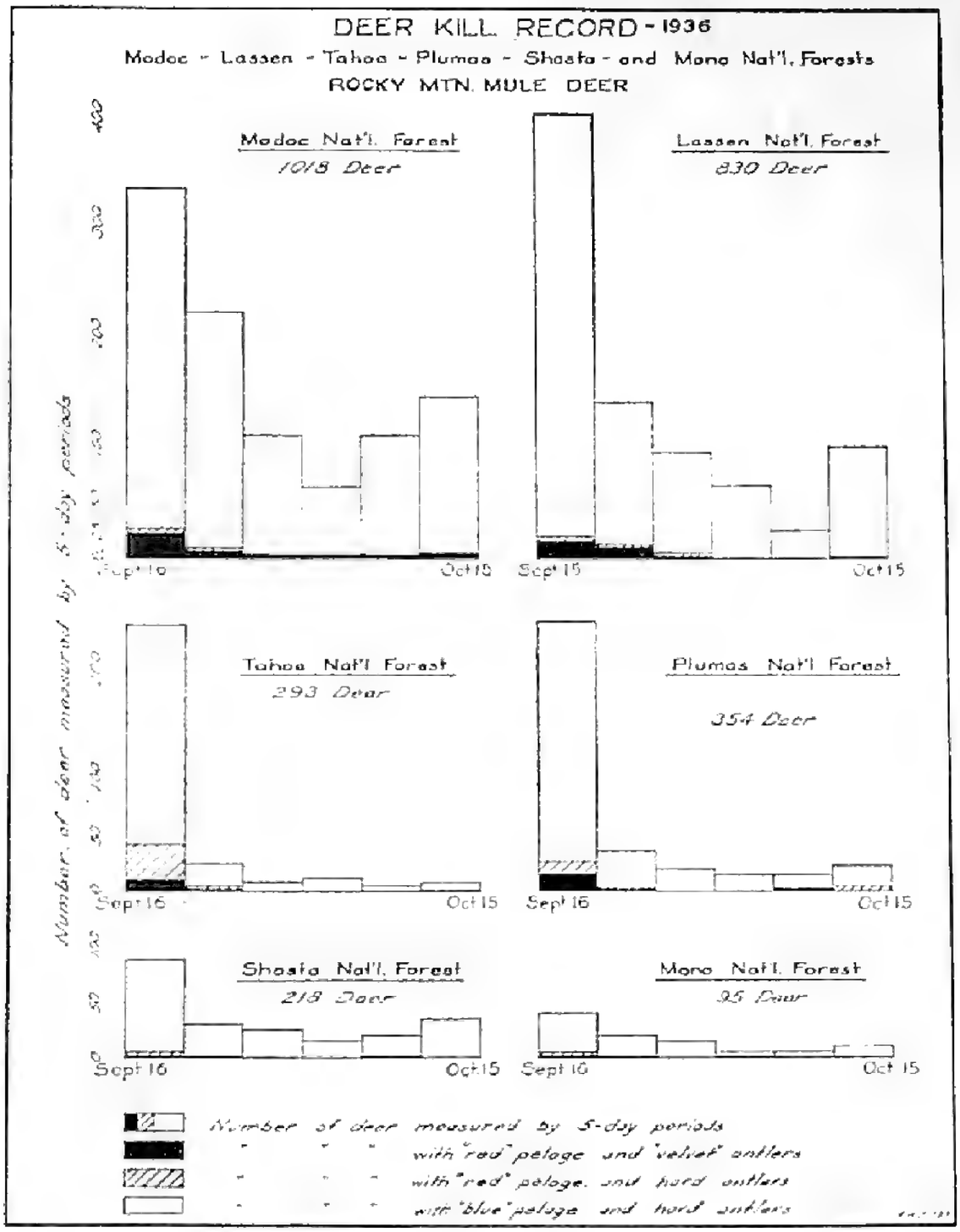


FIG. 57. Number and condition of Rocky Mountain mule deer measured on Modoc, Lassen, Tahoe, Plumas, Shasta and Mono National Forests, by five-day periods, 1936.

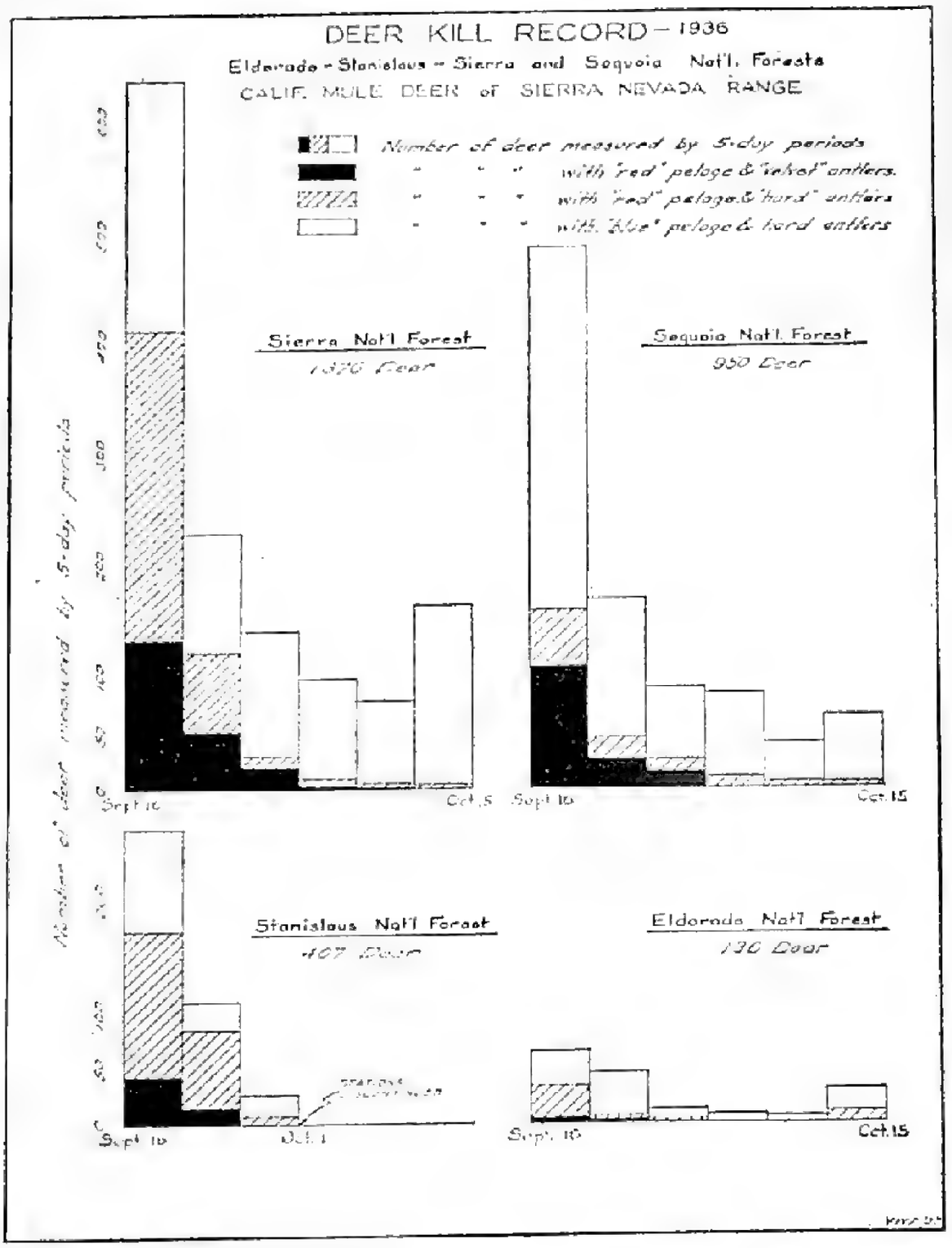


FIG. 58. Number and condition of California mule deer of the Sierra Nevada measured in Sierra, Sequoia, Stanislaus and El Dorado National Forests, by five-day periods, 1936.

Figure 58 shows the antler and pelage conditions of California mule deer taken during the open seasons on the Stanislaus, Sierra, Sequoia and Eldorado national forests. The opening date of the season on these forests was September 16. On this area this race is not in readiness at that opening date, but lags somewhat behind the Rocky Mountain mule deer.

Figure 59 shows that the California mule deer on the San Bernardino Forest were not in condition when the season was opened on

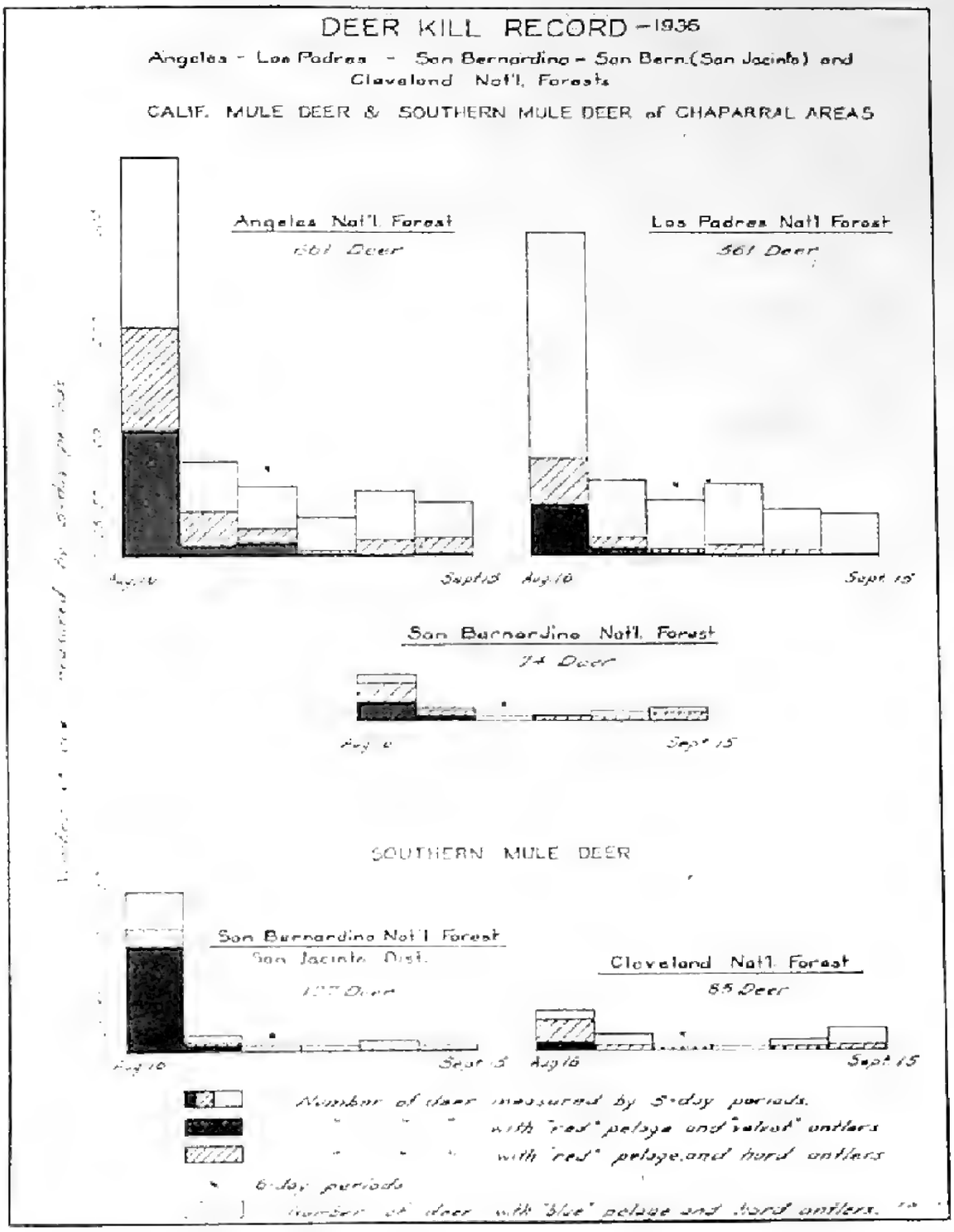


FIG. 59. Number and condition of California mule deer of the chaparral areas measured on Angeles, Los Padres and San Bernardino National Forests, and southern mule deer measured on San Bernardino (San Jacinto District) and Cleveland National Forests, by five-day periods, 1936.

August 16. This date was changed to September 16 by the 1937 session of the State Legislature.

In figure 59 is also shown the condition of the California mule deer on Los Padres Forest. On August 16, the California mule deer on this forest are in fairly good condition and differ considerably from the same race of deer found on the Angeles and other forests. At the

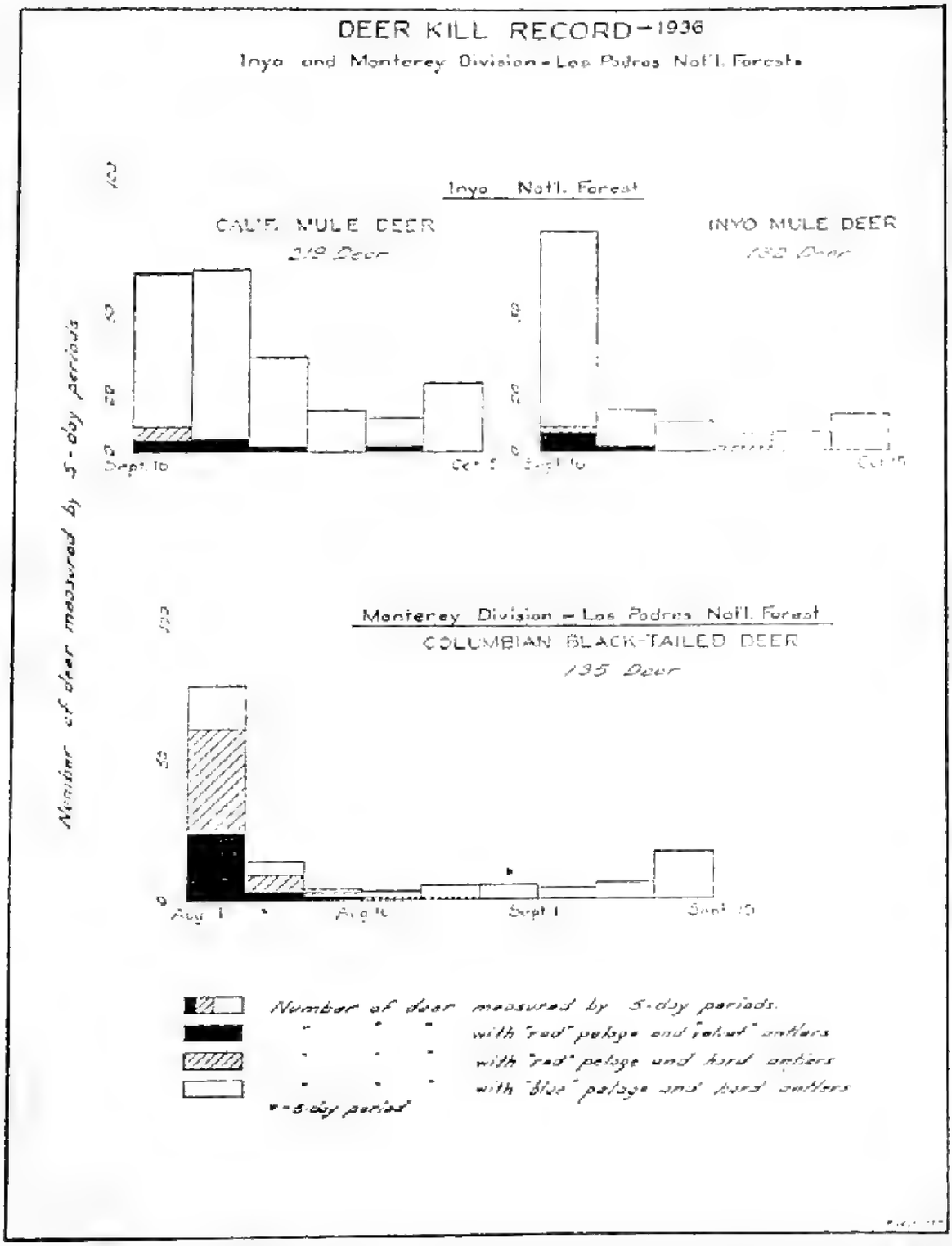


FIG. 60. Number and condition of California mule deer and Inyo mule deer measured on the Inyo National Forest and Columbian black-tailed deer measured on the Monterey Division of Los Padres National Forest, by five-day periods, 1936.

present time the season opens on August 1, as established at the 1937 session of the State Legislature. This date is much too early if deer with hardened antlers or blue coats are wanted as trophies.

The southern mule deer, as described by Cowan, is found in the extreme southern part of the State. The range of this deer includes the San Jacinto Ranger District of the San Bernardino National Forest and the entire Cleveland National Forest which extends to within a few miles of the Mexican border.

Figure 59 shows the condition of antlers and pelage of this race killed from August 16 to September 15, 1936. These deer are not prime on August 16, and are in practically the same condition as the California mule deer found on the Angeles Forest. On the same chart is a graph which indicates that the deer on the Angeles Forest were also far from being in prime condition on the opening date of August 16, 1936. On this date, 150 deer out of approximately 250 deer killed were in red coats. In 1937, the season opened on September 16, which is a much better date so far as trophies are concerned.

The Inyo mule deer, also recently described and separated from the California mule deer by Cowan, is more nearly related to the Rocky Mountain mule deer as far as time of condition is concerned. The opening date for the Inyo mule deer, like that for the Rocky Mountain mule deer, is quite satisfactory. The few found in velvet antlers and red coats after September 15 are generally immature animals which appear to condition later than the mature males.

Figure 60 contains two graphs for the Inyo Forest, showing the condition of the California mule deer and the Inyo mule deer. As far as the records are concerned, the two races are almost identical. It shows that possibly the Inyo mule deer extends farther south than has been described. Deer measured near Monache have the same tail characteristics as the Inyo mule deer. Thus, the deer separated as being California mule deer on the Inyo Forest are quite possibly the Inyo mule deer.

In figure 60 is also shown the condition of the Columbian black-tailed deer on the Monterey Division of Los Padres Forest. These deer are not in condition readiness until August 16. The season here opens August 1, at which time many deer are in red coats and velvet antlers.

It is generally assumed that the closing date of a season should be set relative to the rutting season. The data collected show almost no conflict in this regard. In the September 16-October 15 season, the California mule deer showed the largest number of bucks with swollen necks. These are taken during the last few days of the open season. Further study is needed to determine the point during the rutting season at which the quality of meat starts to decline and also the average date the buck becomes less fearful of man on account of the mating urge. When these are determined, the proper date in respect to quality of meat and quality of sport may be indicated.

Figure 61 compares the 1936 and 1937 antler and pelage conditions of the deer killed on the Trinity and Sequoia national forests, by week intervals. Slight differences are noted between the two years, but in general the time of condition readiness corresponds for the two seasons. This study must be carried on for a number of years in order to determine more accurately the variation that occurs from year to year. However, it is believed that the present studies may be used as a basis for opening and closing dates until such time as more records are available.

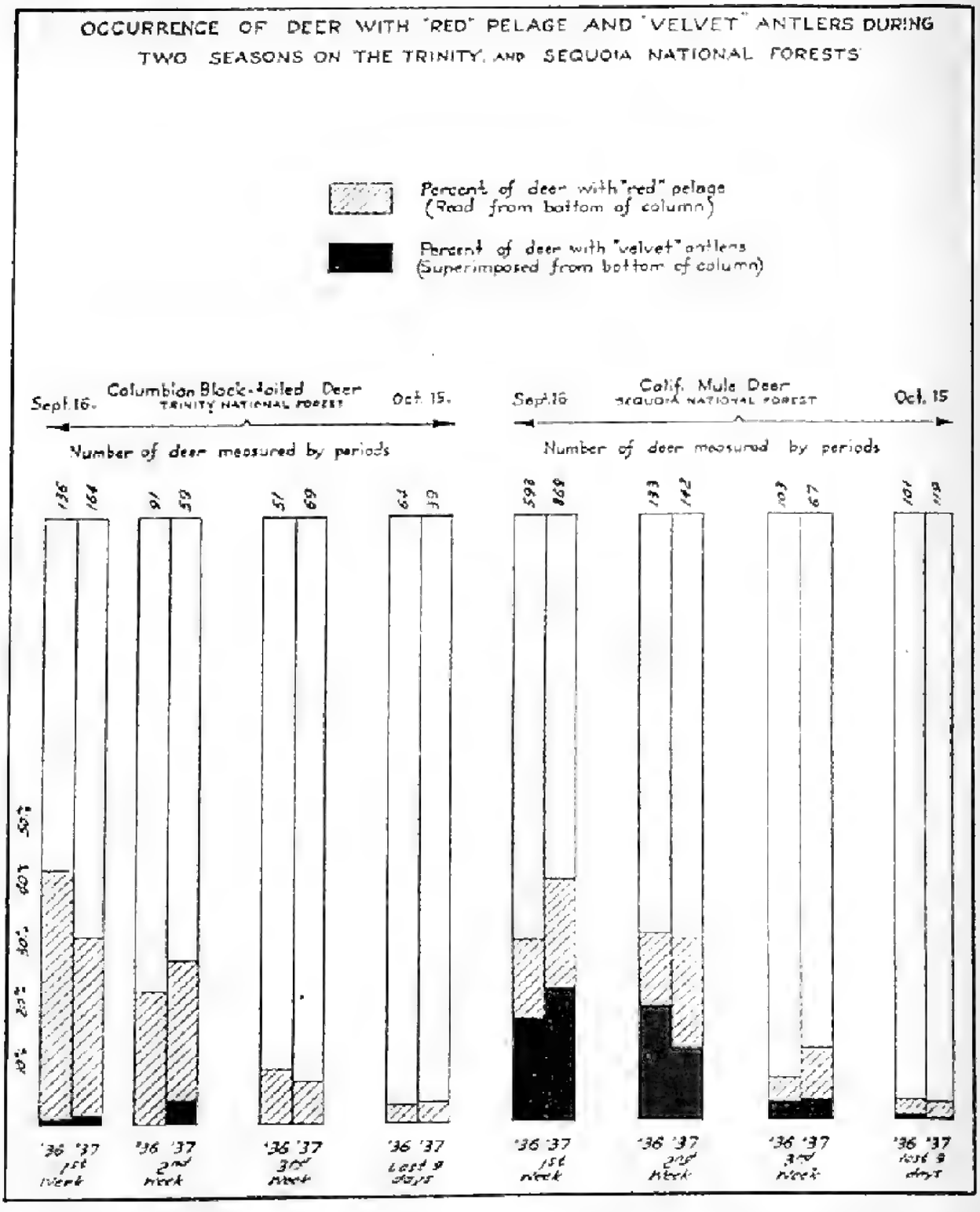


FIG. 61. Comparison of the condition of deer during the 1936 and 1937 seasons; Columbian black-tailed deer on Trinity National Forest, and California mule deer on Sequoia National Forest.

The foregoing discussion shows the following relationships between dates of opening seasons for hunting and the condition of antlers and pelage.

1. The Columbian black-tailed deer on the Mendocino, Trinity and Klamath forests condition at the same time. An opening date after September 15 will permit taking most of these deer in prime condition.

2. The Rocky Mountain mule deer are in excellent condition at a date of September 16 or thereafter. Thus, it is quite satisfactory to have a hunting season opening on the same date with the Columbian black-tailed deer of northern California when the deer are prime.

3. The California mule deer of the Sierra Nevada lag somewhat in condition readiness behind the Rocky Mountain mule deer and the Columbian black-tailed deer. The present opening date of September 16 is somewhat too early, *but not enough to justify a separate season.* September 25 would find a larger proportion of the deer in this area in prime condition.

4. The Inyo mule deer are closely related to the Rocky Mountain mule deer in time of condition readiness after September 15.

5. The California mule deer and the southern mule deer of southern California, excepting Los Padres Forest, are in prime condition at the same time. A season to open after September 15 will find these deer in condition readiness. However, these deer show evidence of the approaching rutting season shortly after October 10, and if the season were to open September 15, it should not extend beyond October 15. The hunting effort in this area is light during the last week of the season, and at present only a few bucks with swollen necks are taken.

6. The California mule deer and the Columbian black-tailed deer of Los Padres Forest are in condition readiness before the California mule deer of the Sierra Nevadas and the Columbian black-tailed deer of the northern California national forests. These deer are in prime condition soon after August 16.

7. Because of the similarity of dates on which deer are in prime condition, one open season to include all of the national forests excepting Los Padres National Forest is desirable. A season of September 25 to October 25 would be excellent for all forests excepting the Angeles, Cleveland and San Bernardino, which should close not later than October 15. Los Padres Forest should open at a date after August 15 and close before September 20.

The significance of these data in relation to the need for distributing hunting effort throughout the State by the use of two large hunting districts in which deer are prime in each, will be discussed later.

Length of Season Is of Minor Effect in the Control of Hunting Effort

The daily kill and measurement records show that many of the deer are killed and much of the deer hunting takes place during the first few days of each hunting season. Figures 56 to 60 illustrate that the largest hunting effort takes place early in the season. In table 4 is shown the percentage of deer measured each ten days of the 1936 season. While this is not the actual total kill, it is a reliable indicator of the dates on which the deer are taken.

Figure 56 in particular shows the tremendous hunting peak on the Mendocino Forest beginning August 16, 1936. Over 55 per cent of the

deer killed on this forest during seasons totaling 60 days in length were taken during the first seven days of the first open season.

It has been shown that quality and size of deer are inversely proportional to the hunting effort. Thus, it would seem logical to expect that any reduction in season length would tend to further concentrate

Table 4

PERCENTAGE OF DEER MEASURED BY 10-DAY PERIODS—1936 SEASON

Forests	Percentages by 10-day periods				
	First 10 days	Second 10 days	Third 10 days	Fourth 10 days	Remainder of season
Klamath	54.4	17.4	6.0	8.5	13.7
Mendocino	57.0	13.0	14.5	7.0	12.5
Trinity[1]	18.7	27.7	29.4	13.4	10.8
Shasta	53.8	18.2	28.0	.....	.....
Modoc	55.1	17.0	27.9	.....	.....
Lassen	65.3	19.4	15.3	.....	.....
Plumas	80.0	10.1	9.9	.....	.....
Tahoe	83.5	9.6	6.9	.....	.....
Mono	63.1	21.1	15.8	.....	.....
El Dorado	70.1	9.6	20.3	.....	.....
Stanislaus[2]	65.1	23.8	11.1	.....	.....
Sierra	63.2	17.9	18.9	.....	.....
Sequoia	69.1	18.7	12.2	.....	.....
Los Padres	65.6	20.5	13.9	.....	.....
Los Padres (Monterey Division)	66.1	5.1	7.3	7.3	14.2
Angeles	67.6	14.8	17.6	.....	.....
San Bernardino	70.2	5.5	24.3	.....	.....
San Bernardino (San Jacinto Division)	88.6	3.4	8.0	.....	.....
Inyo	60.7	21.9	17.4	.....	.....
Cleveland	60.0	5.9	34.1	.....	.....

[1] Only a small part of the Trinity Forest was open on September 1 in District 1½.
[2] By 5-day periods, from September 15 to October 1.

deer hunters and make for less satisfactory sport. It would not eliminate the opening and closing peaks during which the bulk of the deer are killed.

The "One Buck Limit" and "Forked Horn" Legislation Apparently Are Not Preserving Quality of Deer Crop on the Modoc National Forest

During 1935 and 1936 in all parts of this State, except District 1¾, the season limit was two males with forked antlers or better, spike bucks being protected. The Modoc National Forest is in the much discussed hunting District 1¾ in which the deer had the protection of a one buck limit since 1927. In addition, the forked horn antler restriction was in effect on Rocky Mountain mule deer in District 1¾ from 1927 to 1935. Thus, District 1¾, which includes the Modoc and parts of the Shasta, Lassen and Plumas national forests, has had these dual measures of protection. Most of the Plumas and all of the Tahoe national forests are in District 1. Here the bag limit is two male deer and forked horned males may be killed legally.

The analysis of the Rocky Mountain mule deer crops of the Modoc and Tahoe national forests shows that in spite of the one buck limit and forked horn restriction, the Tahoe Rocky Mountain mule deer crop

is markedly superior in quality. Figure 62 shows the difference between the two forests' deer crops in the percentage of each antler beam diameter class appearing in the crop.

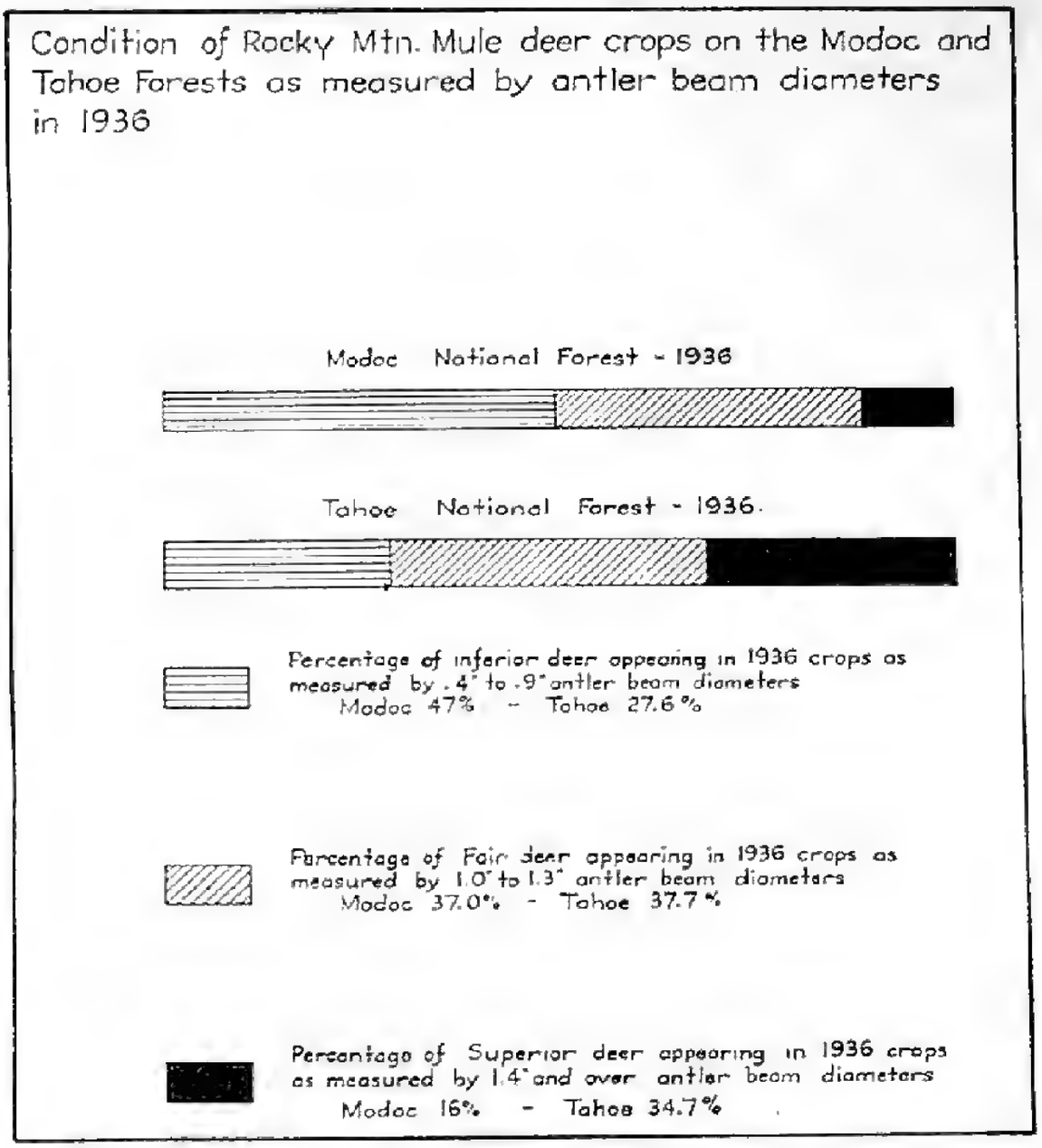


FIG. 62. Comparison of the condition of Rocky Mountain mule deer crops on the Modoc and Tahoe National Forests in 1936, as measured by antler beam diameters.

It will be noted that the graph shows the superior antler beam diameter of 1½ inches is represented much better on the Tahoe National Forest. Apparently, the heavy hunting pressure exerted on the Modoc Forest has offset the value of the one buck limit and the forked horn antler class restriction.

The use of this illustration is to show that *differences of quality* occur within the same race of deer on adjacent areas and that these differences are due to hunting effort.

This would not indicate that the one buck limit and forked-horn law are not useful as control measures but rather that the *heavy hunt-*

ing pressure exerted on the Modoc Forest has offset, to a certain degree, the combined effect of these two measures.

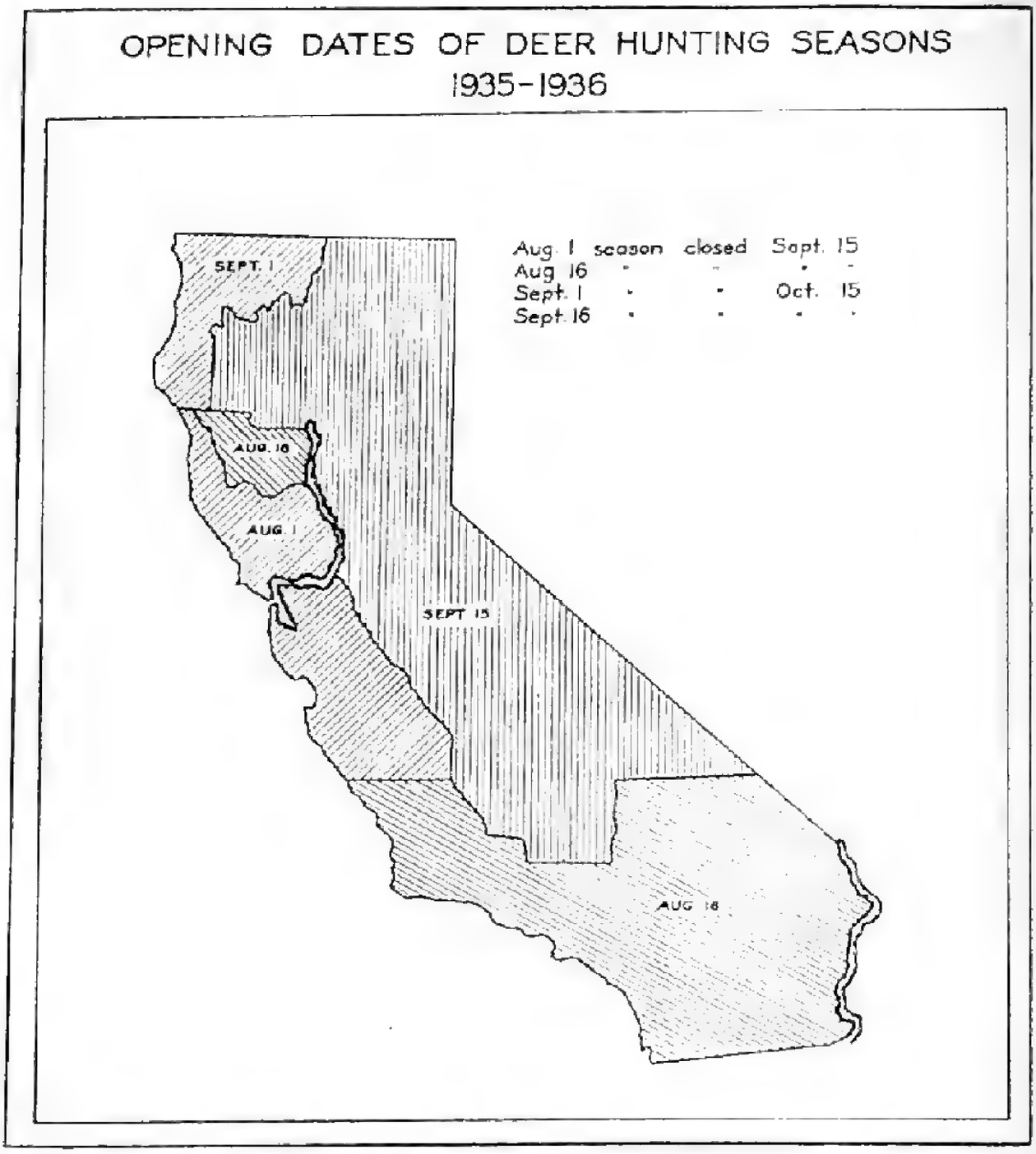


FIG. 63. Map of California showing deer hunting districts with the seasons in effect during the 1935 and 1936 seasons.

Hunting Effort Poorly Distributed Over Deer Range Because of Seasons Opening on Four Different Dates

In order to understand the 1935-1936 deer seasons in this State a map is presented (see Fig. 63) to better illustrate the progressive opening of districts to deer hunting.

1. Districts 2, 2½ and 3 opened August 1 and closed September 15. The Monterey Division of Los Padres Forest is affected by this opening date.

2. Districts 2¾, 4 and 4¾ opened on August 16 and closed September 15. This includes part or Los Padres, all of the Angeles, San Bernardino and Cleveland forests and most of the Mendocino Forest.

3. District 1¼ opened September 1 and closed September 30. This includes all of the Klamath Forest and small parts of the Trinity and Shasta forests.

4. Districts 1, 1¾ and 4½ opened September 16 and closed October 15. This includes all of the Modoc, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Sequoia, Mono and Inyo forests, a large part of the Trinity and Shasta, and a small portion of the Mendocino Forest.

The combined seasons were 2½ months long, with four different opening dates. This made it possible for hunters to travel from one open district to another. It caused tremendous hunting pressure during the opening week of each season and resulted in unusual peaks. This effort is shown geographically in figures 56 to 60 for the 18 national forests in relation to the open seasons.

Since the 1936 season, the "Two Seasons Deer Bill" has passed the State Legislature and was signed by the Governor, taking effect in 1937.

Hunting Effort Must Be Distributed in Order That Length of Seasons, Bag Limits and Antler Class Restrictions May Be Fully Effective

It has been shown in the preceding sections that in certain areas, particularly the Angeles, Mendocino and Modoc national forests, the quality of the deer crop is inferior due to overhunting. It has also been shown that the four consecutive hunting seasons caused unusually heavy hunting pressure, with the following results:

1. Hunting effort was not proportional to length of season. A shorter season would not be effective in controlling overhunting.

2. Bag limit of one buck was ineffective in preserving quality of deer crop under heavy hunting effort.

3. Forked horn antler class restriction likewise was ineffective in preserving quality of deer crop under heavy hunting effort.

It is apparent that control of overhunting and especially control of concentrated hunting on the smaller areas must be effected as the first step in the management of the cropping process if quality is to be preserved.

In Figure 64 is shown a suggested realignment of hunting districts as presented by the Forest Service through this study. To the large district (season, September 16 to October 15) should be added District 2¾ to open at the same time. This would, as has been shown, allow further distribution of hunting effort and permit the taking of prime deer on the Mendocino National Forest. The smaller of the two districts includes the coast deer, both Columbian black-tailed and California mule deer. This season should open August 16, at a time when the deer are approaching prime condition.

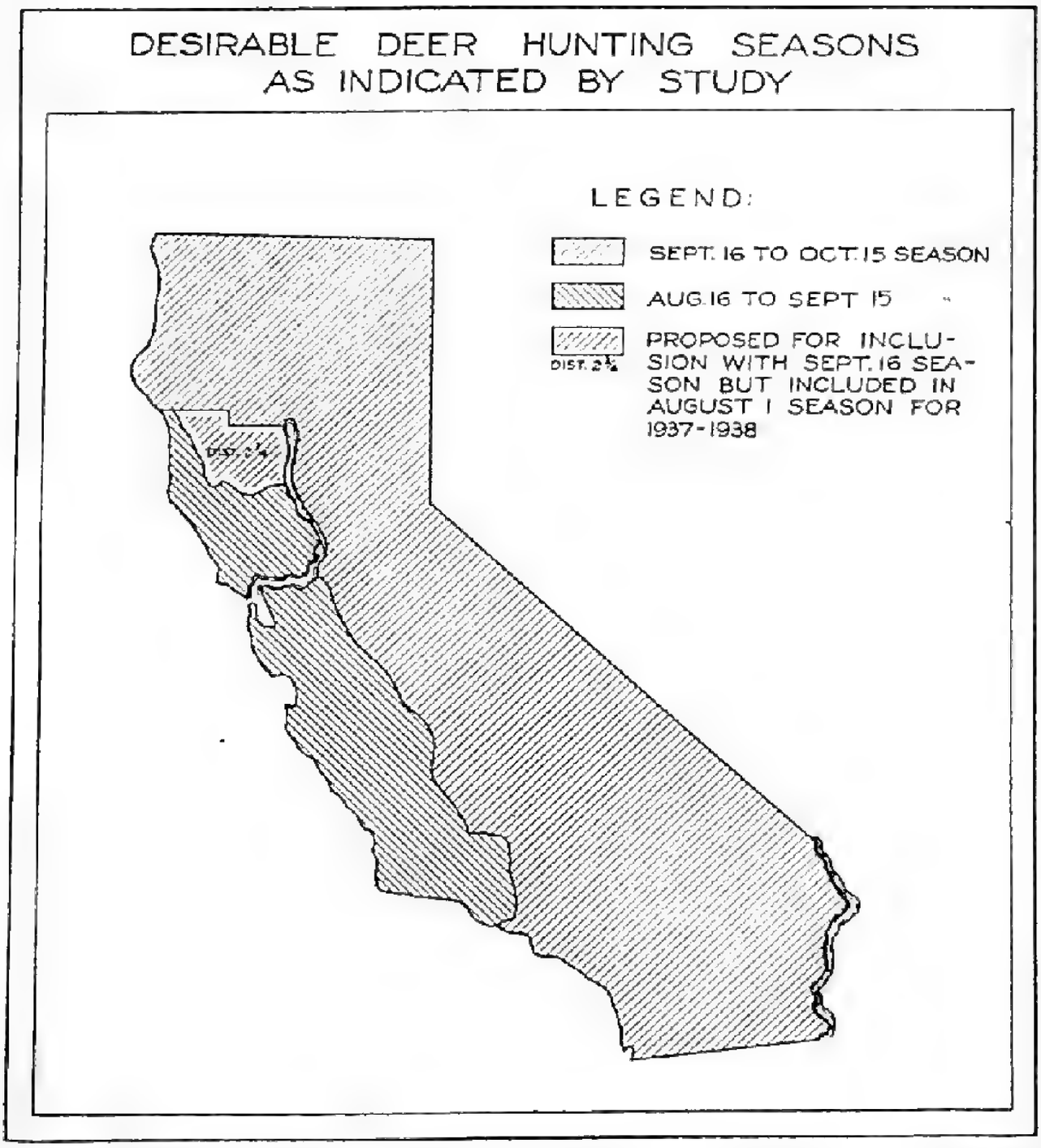


FIG. 64. Map of California outlining desirable deer hunting seasons as indicated by the study.

The present boundaries of the two districts need refinement, since at the present time the northern and southern limits of the coast district are on political rather than ecological boundaries. This refinement may be made through the careful use of antler and pelage condition records.

Because the coast district is small, is close to centers of large population and is relatively easy of access, it is obvious that if the quality of deer and of the sport is to be preserved this area will need special treatment in the future.

The deer in the coast district go into the rut shortly after September 15. This has been determined from a series of fawn birth records. If all of the State were included in a season to open after September 15, the deer in the coast district would be too easily killed because they are fearless during the rutting season.

FIG. 65. A fine virile "head" of a Columbian black-tailed deer taken on the Klamath National Forest by Forest Ranger John Williams. On the Klamath Forest the highest percentage of superior bucks is taken. It appears this is because only a small percentage of immature deer is killed (20 per cent in 1936), which leaves more young bucks to mature and replace the breeding males in the herd.

Problems of Coast District

The problems concerning the hunting of deer on the relatively small coast district are defined as follows:

1. Maintenance of numbers in face of the intense and growing hunting effort.

2. The need for improvement in quality of the males of the breeding herd as shown by the deer kill data.

3. Provide good sport for hunters and still maintain numbers and quality of the males of the breeding herds.

The problems concerning deer hunting in the coast district must be subjected to further study.

Flexible Control Measures Over Seasons and Areas Needed to Distribute Hunting Effort

The result of this study shows that there is need for distributing the hunting effort over the game range. Although the use of two seasons is advocated as the first step to be taken, seasonal control alone will not be fully effective in distributing the hunting effort.

The present system of legislative control is inadequate to provide for the refinements in management needed. Improvement of game herds is so closely related to local factors that good management is necessarily dependent upon a flexible system of control to meet the local condition of environment and hunting demand.

Refinement of control of the hunting effort has not yet been attempted in this State but above all it is believed this is one of the most important problems concerned with the quality of our deer herds.

FIG. 66. In 1936 the crop of deer taken on the Mendocino National Forest showed 60 per cent of the deer killed had heads of the caliber shown above, in contrast to 22 per cent on the Klamath Forest.

In addition to taking a high percentage of immature animals on the Mendocino Forest, many of them (43 per cent in 1936) were still with velvet antlers during the first 10 days of the season opening August 16. These immature bucks as well as the mature animals will weigh from 10 to 15 pounds more if taken after September 15. In 1936, 58 per cent of the deer measured weighed less than 100 pounds dressed. (See Mendocino records in appendix, Table 7.)

Use of Deer Kill Records

This study has shown that records of a large sample of the deer crop can be obtained in the field. For some areas, an adequate sample of actual weights may be obtained which will show the size trend. On most forests the measurement of antler beam diameters must be depended upon to show size trends because of the difficulty of obtaining adequate weight samples.

Deer kill records, *i.e.*, records of quality, number killed and hunting effort by definite areas, may be used by game administrators to ascertain the condition of the game on individual areas before harvesting methods are applied and to ascertain the effect of these methods on the game herd.

A great deal of our game legislation has become law long after the need had developed. Much of it has been passed without benefit of thorough field investigation, and laws have been repealed before the effects of good or poor management measures could be known. Game has such a tremendous appeal to so many people that management methods proposed may be carried by emotional drive rather than accurate knowledge. The enactment of game laws without first being prepared to check the results accurately, seems footless.

Thus, deer kill records may be used not only to point out trends in the number and quality of the deer crop, but as stated by Conner (1937), "to combat destructive legislation."

Future Studies Needed

This study has shown that distribution of the hunting effort is needed to relieve heavy pressure on certain areas. The management tools used to date to control hunting effort are seasons, bag limits, antler class restrictions and game refuges. Where corrective measures are used to improve the quality of a deer crop, studies should be made to follow through so that results of these corrective measures may be known.

Game refuges, especially small escape refuges, have not been discussed in this article as a game management tool because so little is known of the mechanics of their operation. Studies are needed to show their relationship to deer hunting. There are in this State over two and one-quarter million acres of big game range closed to hunting by refuge and fire closures. This tremendous area if opened to hunting would permit distribution of hunting effort and might do more for deer hunting than the present system of management. A study of these game refuges is badly needed to learn of their efficiency as preserves for breeding males and as escape coverts.

The use of antler class restrictions, *i.e.*, protection of spike and forked horned deer, needs further study. The forked horn law may prove to be one of the best tools for the benefit of quality conditions of the male population under heavy hunting pressure.

In order that the ages of forked horned deer, or the 1 x 2 and 2 x 2 antler classes, may be better known, a study of age classes is needed. A start toward this study has been made by Tracy I. Storer of the Department of Zoology, University of California, at Davis, California. The Forest Service is collecting a series of fifty lower jaws of forked horned deer of each race of deer in this State for age determination.

The deer kill records obtained in this study may be separated by cover types and topographic units. Thus, the condition of a deer crop may be studied in relation to the environment. Environmental studies are needed to determine what ratio of food, cover, water and predation are geared together to produce quality and quantity of game. The area of high production should be studied as to the mechanics of the game range.

FIG. 67. A fine 4 x 4 point head of California mule deer from the Sierra National Forest. In 1936 approximately 16 per cent of the deer measured had heads of this quality. During the same season the crop of California mule deer on the Angeles National Forest had only 3.7 per cent of the crop with heads of the quality shown here. The above head has an antler beam diameter measurement of 1.5 inches. Antler beam diameters of 1.4 inches and better are designated as the "good and superior" class in judging size and quality of the crop.

FIG. 68. A 1 x 2 head of California mule deer from the Angeles National Forest. In 1936, 70 per cent of the crop was composed of 1 x 2 and 2 x 2 point heads of immature bucks.

While the number of bucks taken annually on the Angeles Forest has been sustained, the quality of the crop is poor and in need of improvement.

Other studies needed are those concerning herd efficiency which would determine the factors necessary for keeping a herd on a most productive basis.

In order that the studies needed in deer management may be given a proper place, it has been suggested that an area of deer range be set aside for study. On this study area, the Division of Fish and Game should have full regulatory powers. Here, seasons, bag limits, antler class and sex restrictions as well as the environmental factors of food, water, cover and predation, together with hunting effort, may be manipulated and studied. This should result in the promulgation of better game management methods, increased efficiency and the determination of methods for producing bigger and better bucks.

Summary

1. During the open seasons of 1935 and 1936, measurement records were made of over 18,000 deer by members of the Forest Service and other organizations in this region. This record was made mainly by forest officers as part of their regular duties at little additional cost.

Checking stations placed at strategic points on roads, combined with the efforts of roving patrolmen, measured over 50 per cent of the total deer kill on the National Forests. This is an adequate sample on which to base a study of the trends of the deer crop.

2. The deer kill measurements included records of the daily kill and hunting effort throughout the season; antler size and antler condition measurements; pelage and flesh condition observations which were recorded; and size determinations by weighing dressed deer.

The record for each deer was punched on a card for tabulating on the Hollerith machines. This method permitted compilation and grouping of the measurements by forests and deer races. Refinement of analysis of the condition of the deer crop by small areas is made possible through the use of the Hollerith system.

3. Records of dressed weights, antler points, antler spread and antler beam diameter measurements show the following:

a. Weight measurement records shows that only the southern group of forests may secure an adequate random sample of deer weights. This record is the most accurate for determining size and trend of sizes in the deer crop. In other areas antler measurements must be used as an indicator of size.

b. Antler measurements, *i.e.*, antler beam diameter, antler points and antler spread measurements when correlated with dressed weights of deer show that:

FIG. 69. Showing head of a southern mule deer from the Cleveland National Forest. This 2 x 2 point head has a spread of 15.5 inches and an antler beam diameter of 1.4 inches one inch above the burr. This deer was in his prime when taken as shown by condition of the teeth. The weight was 148 pounds dressed. This illustrates the use of the antler beam diameter measurements as being more accurate as a size and age indicator than antler points.

(1) The antler beam diameter measurement is more consistent and more closely related to actual weights than antler spread or the number of antler points. The use of the antler beam diameter measurements in lieu of actual weighings is recommended for the Rocky Mountain mule deer race and as a fair means of determining size trends for all other deer races occurring in the National Forests of California. It is important that these measurements be applied to crops of deer as a whole and not to individual animals.

(2) A combination of spread and antler beam diameter measurements could best be used to show size trends for the California mule deer race of the Sierra Nevada range.

(3) The use of antler points in showing size trends is of some value, although its value is not as high as either the antler spread or antler beam diameter measurements as a size indicator.

4. Tables showing the 1936 deer kill record by antler point numbers, antler spreads by two-inch classes, antler beam diameters by 2/10-inch classes and dressed weight in ten-pound classes, have been prepared for each deer race on each National Forest. This record is considered a fairly accurate description of the present condition of the male deer population on the National Forests.

5. The antler beam diameter measurements may be used in lieu of actual weight measurements to show trends of size or quality of the deer crop in all races of deer. While this is not as accurate as desirable, it is the best method available for judging the size and relative age condition. As a field method to be used when measuring a large number of deer, it is the best field tool to show the size and quality of the male population appearing in the annual deer crop.

6. Analysis of the quality of the deer crops on the forests when compared to the hunting efforts made on these forests shows that where heavy hunting occurs the crop of deer is inferior in quality; that *qual-*

ity of a deer crop is inversely proportional to the degree of hunting effort. Analysis of the hunting effort, compared with the deer crop by forests and seasons, shows the following tendencies:

a. That length of season is not effective as a control measure of hunting effort. Decrease in the length of the seasons in effect in 1936 would tend to further concentrate the hunters and make deer hunting less satisfactory as a sport.

b. That hunting pressure, if large enough, may offset the effects of a reduced bag limit (one buck limit) in an attempt to preserve the quality of a deer crop.

c. That heavy hunting pressure may also offset the value of additional antler class restrictions (protection of the 1 x 2 and 2 x 2 or forked horned deer) placed to protect the quality of the deer crop.

FIG. 70. Showing a 2 x 2 or forked horned Rocky Mountain mule deer head. Approximately 80 per cent of the Rocky Mountain mule forked horns are only 16 to 18 months of age. This antler class is protected at the present time in District 13. (Note absence of eye guards or brow tines which, according to Cowan, never occur on yearling male Rocky Mountain mule deer.)

d. That overhunting may offset combinations of length of season, bag limits and antler class restrictions, and deterioration of the male deer population will occur in spite of these measures.

e. That it is necessary first to distribute the hunting effort over a large area to prevent concentration of hunters on small accessible areas before length of seasons, bag limits and antler class restrictions may be most effectively used to preserve the quality of the male deer population.

7. Hunters concentrate on the forests at the opening date of each season. This concentration was partly caused in 1936 through the use of four separate opening dates.

During the first ten days of the deer season from 55 to 83 per cent of the deer were taken in each district. At this time some of the deer were not in as good condition as those taken at the end of the season.

Concentration of hunters builds up an unsportsmanlike spirit, causes poor sport and subjects the deer to a great disadvantage.

Hunters concentrate on areas of easy access and easy topography. Many areas in the State are not heavily hunted because of their remoteness or difficulty of hunting.

8. Hunting effort should be distributed over the entire deer range on an area basis where *known serious concentrations occur.* Because most of the hunting takes place (55 to 83 per cent) during the first ten days of the open season, it would be necessary to enforce such regulation for the *first ten days only.* This does not mean limitation of the number of hunters allowed on the deer range, but *distribution of hunters by areas.*

FIG. 71. Showing head of decadent or "Pacific buck" loaned for illustration by Mr. Gus Nordquist. This large 2 x 2 head is from a very old deer that had passed his prime and was almost at the end of the trail before taken. The separation of this type of head is possible if antler spread and antler beam diameter measurements are recorded along with point classes.

Areas near large centers of population such as Los Padres and Angeles forests are in need of such regulation in order to improve the quality of the sport.

9. A start toward distribution of hunting effort may be made by opening one area (as large as possible) at the time when the deer races in this area, as shown by the antler and pelage condition records, are in condition readiness. In this State such an area should open after September 15 and include all of the National Forests, except Los Padres, in one large district. The Angeles, Cleveland and San Ber-

nardino forests should close not later than October 15 because the approach of the rutting season is apparent at that time.

10. Los Padres National Forest should be included in the coast season to open after August 15. Since this coast district is relatively small and near large centers of population, this area may need special consideration and treatment in order to preserve the quality of the deer crop. In order to do this, hunters should be distributed *during the first ten days of the season only* on an area basis. A series of small escape refuges might be established and additional protection given through the use of a "one buck limit" and possibly the "forked horn law."

11. A demonstration unit of game range is needed on which the factors of food, water, cover, predation and the kill factor may be studied, to the end that sustained yield of the deer crops, both as to quality and quantity, may best be maintained. The California Division of Fish and Game should be given full regulatory powers to manage such an area for study and demonstration.

12. Studies of the deer crop by forests show that where a large percentage of the crop of male deer is inferior, *i.e.*, 1x2 and 2x2 point heads, low in weight, of small antler beam diameter and small spread measurement, few superior animals appear in the crop. Thus, if superior deer do not appear in the crop they are not being killed off; on the contrary it is apparent that shortages of superior deer in the annual crop are due to the taking of so many immature deer; that due to persistent overhunting the superior deer seldom develop, as young bucks are not allowed to grow up.

13. The application of methods used to show trends of the fisheries resources by the California State Fisheries Laboratory when applied to the deer resource of the national forests of this State show the following:

a. Total numbers of deer are not reduced in the kill on heavily hunted areas because of the law that protects the female deer and young males.

b. A reduction in the size of deer appearing in the crop occurs on heavily hunted areas. This is parallel to the reduction of size of the fish appearing in the catch when the area is overfished.

c. Each year hunters go far afield for trophies. An increase in the movement of California hunters to other states and remote parts of this State has been noted. This seems to be a parallel to the movement of the fishermen to far areas and new fields of exploitation off the coast of California.

14. The physical condition of the deer crops by national forests and races varies greatly. In the most remote and less accessible areas the quality of the deer crop is highest. Near centers of large population, the quality of the deer crop is inferior. A summary of the 1936 deer kill analysis as to the physical condition of the deer by races on each national forest is presented.

15. The quality of the deer crop and of the males in the breeding herds has been impaired on areas where concentrated deer hunting

occurs. The kill factor bears an important relationship to the physical quality and well being of future herds. Refinement of harvesting methods is needed to preserve and improve the quality of the deer on these areas of public land.

Summary of 1936 Crop Conditions

In order to give a brief summary of the quality or size conditions found in the deer herds on the 18 national forests, table 5 is presented. The table compares the deer races and forests. The measuring stick used is size, and size is rated upon the antler beam diameter measurements as follows:

Columbian Black-tailed, California Mule, Inyo Mule and Southern Mule Deer

Between 0.4 inches and 0.9 inches = Immature and inferior
Between 1.0 inches and 1.3 inches = Fair
1.4 inches and greater = Good and superior

Rocky Mountain Mule Deer

Between 0.4 inches and 1.1 inches = Immature and inferior
Between 1.2 inches and 1.5 inches = Fair
1.6 inches and greater = Good and superior

While this measuring method is not exact for individual deer, it is a reliable method for indicating size where large numbers of deer are measured.

Table 5

CONDITION OF DEER CROP IN 1936

Condition of 1936 Columbian Black-tailed Deer Crop

Forest	Immature per cent	Fair per cent	Superior per cent
Klamath	20.2	53.1	26.7
Trinity	46.1	42.1	11.8
Mendocino	55.2	36.9	7.9
Shasta	49.3	37.2	13.5
Lassen	54.7	38.2	*7.1
Plumas	50.9	39.6	9.5
Tahoe	27.8	49.6	22.6
El Dorado	33.8	49.3	16.9
Los Padres	44.3	43.6	12.1

* Many superior bucks taken during last few days of the season during storm which were not recorded. These deer were taken adjacent to the Lassen National Park and the adjoining Refuge 1-G.

Condition of 1936 Rocky Mountain Mule Deer Crop

Forest	Immature per cent	Fair per cent	Superior per cent
Modoc	71.0	21.0	8.0
Lassen	74.8	22.0	3.2
Shasta	62.7	29.8	7.5
Plumas	50.3	29.3	20.4
Tahoe	51.4	28.2	20.4
Mono	62.0	31.5	6.5

TABLE 5. CONDITION OF DEER CROP IN 1936—Continued

Condition of 1936 California Mule Deer Crop

Forest	Immature per cent	Fair per cent	Superior per cent
Stanislaus	45.4	42.2	12.4
Sierra	48.1	34.6	17.3
Sequoia	41.6	41.2	17.2
Los Padres	38.4	46.8	14.8
Angeles	65.2	29.0	5.8
San Bernardino	63.6	28.8	7.6

Condition of 1936 Inyo Mule Deer Crop

Forest	Immature per cent	Fair per cent	Superior per cent
Inyo	32.5	48.5	19.0

Condition of 1936 Southern Mule Deer Crop

Forest	Immature per cent	Fair per cent	Superior per cent
Cleveland	34.0	59.9	6.1
San Bernardino	72.2	24.3	4.5

Literature Cited

Babcock, E. B., and Clausen, R. E.
1927. Genetics in relation to agriculture; 2d ed. New York. 673 pp.

Cahalane, V. H.
1932. Age variation in the teeth and skull of the whitetail deer. Cranbrook Institute of Science. Scientific publications, no. 2, 14 pp.

California Division of Fish and Game
1937. Biennial report, 1934-1936.

Conner, Geraldine
1937. Fish and game statistics. California Fish and Game, vol. 23, pp. 113-118.

Cowan, I. M.
1936. Distribution and variation in deer (genus *Odocoileus*) of the Pacific coastal region of North America. California Fish and Game, vol. 22, no. 3, pp. 155-246.

Davenport, C. B., and Ekas, M. P.
1936. Statistical methods in biology, medicine and psychology; 4th ed. New York. 216 pp.

Dixon, J. S.
1934. A study of the life history and food habits of mule deer in California. California Fish and Game, vol. 20, pp. 181-282, 315-354, 85 figs.

Leopold, A.
1933. Game management. New York. 481 pp.

Park, B. C.
1936. Deer weights and antler measurements, Allegheny National Forest, 1935. U. S. Forest Service, Warren, Pa. 13 pp., mimeographed.

Table 6

Klamath National Forest—1936 Deer Kill Records

Species—Columbian Black-tailed Deer

Total kill, estimated 500
Total measured 176

Antler classes—176 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	3	37	9	41	19	43	12	1	0	0	0	0	11	0
Antler classes, by per cent	1.7	21.0	5.1	23 3	10.8	24.4	6.8	0.6	0	0	0	0	6.3	0

Weight classes—68 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	2	5	7	11	7	13	7	8	5	1	1	1	0	0
Per cent, by weight classes	2.9	7.3	10 3	16.2	10.3	19.1	10.3	11.8	7.3	1.5	1.5	1.5	0	0

Diameter classes—160 measured

Diameter classes, by inches	.4- .7	.8- .9	1 0-1.1	1 2-1 3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2 4-2 5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	10	21	50	40	36	4	2	3	0	0	0	0
Per cent, by diameter classes	5.9	14.2	29.6	23.7	21.3	2.3	1 2	1 8	0	0	0	0

Spread classes—169 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	2	6	11	16	29	44	27	18	12	2	1	1	0	0	0
Per cent, by spread classes	1 2	3.5	6.4	9.5	17.2	26.0	16.0	10.7	7.1	1 2	0.6	0 6	0	0	0

Table 7

Mendocino National Forest -1936 Deer Kill Records

Species—Columbian Black-tailed Deer

Total kill, estimated 1,660
Total measured 943

Antler classes—943 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	56	509	92	187	40	34	2	2	0	1	0	0	9	11
Antler classes, by per cent	5.9	54.0	9.8	19.8	4.2	3.6	0.2	0.2	0	0.1	0	0	1.0	1.2

Weight classes—154 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	48	23	19	21	21	15	4	2	1	0	0	0	0	0
Per cent, by weight classes	31.2	15.0	12.4	13.6	13.6	9.7	2.6	1.3	0.6	0	0	0	0	0

Diameter classes—943 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	220	299	236	113	61	10	4	0	0	0	0	0
Per cent, by diameter classes	23.3	31.7	25.0	12.0	6.5	1.1	0.4	0	0	0	0	0

Spread classes—943 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	9	55	169	229	183	154	85	44	15	0	0	0	0	0	0
Per cent, by spread classes	1.0	5.8	17.9	24.3	19.4	16.3	9.0	4.7	1.6	0	0	0	0	0	0

Table 8

Shasta National Forest—1935 Deer Kill Records

Species—Columbian Black-tailed Deer

Total kill, estimated 640
Total measured 430

Antler classes—430 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	23	141	37	87	54	58	12	2	3	1	0	0	11	1
Antler classes, by per cent	5.3	32.8	8 6	20.2	12.6	13.5	2.8	0.5	0.7	0.2	0	0	2.6	0.2

Weight classes—108 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	5	12	16	10	18	6	13	8	6	3	3	5	1	2
Per cent, by weight classes	4.6	11.1	14.8	9.3	16.7	5.6	12.0	7.4	5.6	2.8	2.8	4.6	0.9	1.8

Diameter classes—430 measured

Diameter classes, by inches	4- 7	8-.9	1 0-1 1	1 2-1.3	1 4-1 5	1.6-1 7	1.8-1.9	2 0-2.1	2 2-2 3	2 4-2.5	2.6-2.7	2 8-2 9
Numbers, by diameter classes	108	104	111	49	37	12	5	1	3	0	0	0
Per cent, by diameter classes	25 1	24 2	25.8	11.4	8 6	2 8	1 2	0 2	0 7	0	0	0

Spread classes—430 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	3	27	54	79	65	70	48	34	16	14	12	6	1	0	1
Per cent, by spread classes	0 7	6.2	12 5	18 4	15.1	16 3	11 2	7 9	3.7	3 3	2 8	1.4	0 2	0	0.2

Table 9

Trinity National Forest—1936 Deer Kill Records

Species—Columbian Black-tailed Deer.

Total kill, estimated..... 1,100
Total measured..... 432

Antler classes—132 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	6	109	58	93	36	37	7	2	3	0	0	0	9	12
Antler classes, by per cent	1.4	39.1	13.4	21.5	8.3	8.6	1.6	0.5	0.7	0	0	0	2.1	2.8

Weight classes—86 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	8	13	14	10	13	12	9	2	4	1	0	0	0	0
Per cent, by weight classes	9.3	15.1	16.3	11.6	15.1	13.9	10.5	2.3	4.7	1.2	0	0	0	0

Diameter classes—132 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	75	124	115	67	40	7	4	0	0	0	0	0
Per cent, by diameter classes	17.4	28.7	26.6	15.5	9.3	1.6	0.9	0	0	0	0	0

Spread classes—132 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	16	63	95	76	79	56	24	15	5	0	1	2	0	0
Per cent, by spread classes	0	3.7	14.6	22.0	17.6	18.3	12.9	5.5	3.5	1.2	0	0.2	0.5	0	0

Table 10

Modoc National Forest—1936 Deer Kill Records

Species—Columbian Black-tailed Deer

Total kill, estimated..... 44
Total measured..... 44

Antler classes—44 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	15	2	9	6	8	1	1	0	1	0	0	0	0	1
Antler classes, by per cent	34 9	4 7	20.9	14.0	18.6	2.3	2.3	0	2.3	0	0	0	0	2.3

Weight classes—5 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	0	0	0	0	1	1	0	0	0	2	1	0	0
Per cent, by weight classes	0	0	0	0	0	20.0	20 0	0	0	0	40.0	20.0	0	0

Diameter classes—14 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	9	11	13	7	2	2	0	0	0	0	0	0
Per cent, by diameter classes	20.5	25.0	29.5	16.0	4.5	4 5	0	0	0	0	0	0

Spread classes—44 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	2	5	8	2	5	7	2	7	3	1	1	0	0	1
Per cent, by spread classes	0	4.5	11.4	18 2	4.5	11.4	15.9	4.5	15.9	6.8	2.3	2.3	0	0	2 3

Table 11

Plumas National Forest—1936 Deer Kill Records

Species—Columbian Black-tailed Deer.

Total kill, estimated..... 200
Total measured..... 110

Antler classes—110 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	5	41	17	21	8	16	2	1	0	0	0	0	3	5
Antler classes, by per cent	4.2	34.5	14.3	17.6	6.7	13.5	1.7	0.8	0	0	0	0	2.5	4.2

Weight classes—21 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	0	3	1	1	2	3	2	1	4	0	0	3	1
Per cent, by weight classes	0	0	14.3	4.8	4.8	9.5	14.3	9.5	4.8	18.9	0	0	14.3	4.8

Diameter classes—118 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	29	31	34	13	10	0	1	0	0	0	0	0
Per cent, by diameter classes	24.6	26.3	28.8	11.0	8.5	0	0.8	0	0	0	0	0

Spread classes—110 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	3	9	23	15	13	22	10	9	7	6	0	2	0	0
Per cent, by spread classes	0	2.5	7.6	19.3	12.6	10.9	18.5	8.4	7.6	5.9	5.0	0	1.7	0	0

Table 12

Lassen National Forest—1936 Deer Kill Records

Species—Columbian Black-tailed Deer.

Total kill, estimated..... 980
Total measured..... 827

Antler classes—827 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	29	302	115	168	72	75	21	4	2	0	0	0	17	22
Antler classes, by per cent	3.5	36 5	13.9	20.3	8.7	9.1	2.6	0.5	0.2	0	0	0	2.0	2 7

Weight classes—107 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	9	16	10	11	14	16	11	3	7	5	2	1	1	1
Per cent, by weight classes	8 4	15 0	9 3	10.3	13.1	15 0	10 3	2 8	6 5	4.7	1.9	0.9	0.9	0 9

Diameter classes—827 measured

Diameter classes, by inches	4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	193	260	1.8	118	46	7	4	0	0	1	0	0
Per cent, by diameter classes	23 4	31 4	23 9	14 3	5.6	0 8	0 5	0	0	0.1	0	0

Spread classes—727 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	4	14	90	38	137	140	115	94	61	21	7	3	3	0	0
Per cent, by spread classes	0 6	1 9	12 4	5.2	18.8	19.3	15.8	12.9	8 4	2.9	1.0	0 4	0.4	0	0

Table 13

Tahoe National Forest 1936 Deer Kill Records

Species—Columbian Black-tailed Deer.

Total kill, estimated..... 460
Total measured..... 272

Antler classes 272 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	4	88	27	52	24	49	6	2	1	1	0	0	14	4
Antler classes, by per cent	1.5	32.4	9.9	19.1	8.8	18.0	2.2	0.7	0.4	0.4	0	0	5.1	1.5

Weight classes—97 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	2	2	11	9	13	15	12	9	7	5	5	4	1	2
Per cent, by weight classes	2.1	2.1	11.3	9.2	13.4	15.5	12.3	9.2	7.3	5.2	5.2	4.1	1.0	2.1

Diameter classes—271 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	28	48	84	49	33	13	8	8	0	0	0	0
Per cent, by diameter classes	10.3	17.7	31.0	18.1	12.1	4.8	3.0	3.0	0	0	0	0

Spread classes—272 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	10	24	43	39	43	26	23	32	11	9	6	3	1	2
Per cent, by spread classes	0	3.7	8.8	15.8	14.3	15.8	9.6	8.5	11.8	4.0	3.3	2.2	1.1	0.4	0.7

Table 14

Los Padres National Forest—1938 Deer Kill Records

Species—Columbian Black-tailed Deer.

Total kill, estimated..... 200
Total measured..... 135

Antler classes—135 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. D.
Number, by antler classes	13	91	9	10	5	0	0	0	0	0	0	0	0	7
Antler classes, by per cent	9.6	67.4	6.7	7.4	3.7	0	0	0	0	0	0	0	0	5.2

Weight classes—53 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	10	5	10	10	9	4	2	3	0	0	0	0	0	0
Per cent, by weight classes	18.9	9.5	18.9	18.9	16.9	7.5	3.8	5.6	0	0	0	0	0	0

Diameter classes—135 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	11	49	44	15	13	1	2	0	0	0	0	0
Per cent, by diameter classes	8.2	36.3	32.6	11.1	9.6	0.7	1.5	0	0	0	0	0

Spread classes—135 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	4	24	25	24	31	21	4	1	1	0	0	0	0	0
Per cent, by spread classes	0	3.0	17.8	18.5	17.8	33.0	15.6	2.9	0.7	0.7	0	0	0	0	0

6—59800

Table 15

Modoc National Forest—1936 Deer Kill Records

Species—Rocky Mountain Mule Deer.

Total kill, estimated..... 2,850
Total measured..... 1,052

Antler classes—1,018 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	35	327	104	190	105	185	30	10	3	1	0	0	0	19
Antler classes, by per cent	3.4	32.1	10.2	19.5	10 3	18.2	3 0	1.0	0.3	0.1	0	0	0	1.9

Weight classes—183 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	2	6	8	14	12	11	14	18	20	14	13	15	8	38
Per cent, by weight classes	1 1	3.3	4.3	7.7	6.6	6.0	7.7	9 8	10.9	7.7	7.1	8.2	4.3	15 3

Diameter classes—1,048 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1 6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	211	289	262	140	87	29	20	7	1	1	1	0
Per cent, by diameter classes	20.1	27.5	25.0	13.4	8.3	2.8	1.9	0.7	0.1	0.1	0.1	0

Spread classes—1,052 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	4	40	121	160	95	114	146	137	80	73	46	19	11	6	0
Per cent, by spread classes	0.4	3.8	11.5	15.2	9 0	10.8	13.9	13.0	7.6	6.9	4.4	1.8	1.1	0.6	0

Table 16

Shasta National Forest—1938 Deer Kill Records

Species—Rocky Mountain Mule Deer.

Total kill, estimated 880
Total measured 218

Antler classes—218 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	3	61	14	41	30	49	8	3	3	0	0	0	5	1
Antler classes, by per cent	1.4	28.0	6.4	18.8	13.7	22.5	3.6	1.4	1.4	0	0	0	2.3	0.5

Weight classes—28 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	0	0	4	1	0	3	2	3	5	2	0	3	5
Per cent, by weight classes	0	0	0	14.3	3.0	0	10.7	7.1	10.7	17.9	7.1	0	10.7	17.9

Diameter classes—218 measured

Diameter classes, by inches	.4- .7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	35	46	56	43	22	11	3	1	0	1	0	0
Per cent, by diameter classes	16.0	21.1	25.7	19.7	10.1	5.0	1.4	0.5	0	0.5	0	0

Spread classes—218 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	3	28	20	13	20	21	48	23	19	15	7	0	1	0
Per cent, by spread classes	0	1.4	12.8	9.2	6.0	9.2	9.6	22.0	10.6	8.7	6.9	3.2	0	0.4	0

Table 17

Lassen National Forest—1936 Deer Kill Records

Species—Rocky Mountain Mule Deer.

Total kill, estimated 860
Total measured 830

Antler classes—830 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	31	224	76	172	84	158	21	10	5	2	0	0	32	15
Antler classes, by per cent	3.7	27.0	9.2	20.7	10.1	19.0	2.6	1.2	0.6	0.2	0	0	3.9	1.8

Weight classes—184 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	9	13	13	15	16	18	22	11	7	14	11	12	6	17
Per cent, by weight classes	4.9	7.1	7.1	8.1	8.7	9.8	12.0	6.0	3.8	7.6	6.0	6.5	3.2	9.2

Diameter classes—830 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	150	239	231	113	70	22	3	2	0	0	0	0
Per cent, by diameter classes	18.1	28.8	27.9	13.6	8.4	2.7	0.3	0.2	0	0	0	0

Spread classes—830 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	4	18	73	116	85	98	105	97	86	58	35	24	13	15	0
Per cent, by spread classes	0.5	2.2	8.8	13.9	10.2	11.8	12.7	11.7	10.4	6.9	4.6	2.9	1.6	1.8	0

Table 18

Plumas National Forest—1936 Deer Kill Records

Species—Rocky Mountain Mule Deer.

Total kill, estimated..... 680
Total measured..... 351

Antler classes—354 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Old	P. B.
Number, by antler classes	22	92	35	57	36	72	11	3	5	2	0	0	13	6
Antler classes, by per cent	6.2	26 0	9.9	16.1	10 2	20.3	3.1	0 8	1 4	0.6	0	0	3.7	1 7

Weight classes—24 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	4	0	0	1	1	3	2	0	6	0	1	3	3
Per cent, by weight classes	0	16.7	0	0	4 1	4.1	12.5	8.4	0	25 1	0	4.1	12.5	12 5

Diameter classes—354 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1 4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	69	64	81	57	47	16	8	10	0	1	1	0
Per cent, by diameter classes	19 5	18.1	22.9	16 1	13 3	4.5	2.2	2 8	0	0.3	0 3	0

Spread classes—354 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	1	8	38	41	38	32	44	41	36	27	24	9	11	4	0
Per cent, by spread classes	0.3	2 3	10 7	11.6	10 7	9 0	12 4	11.6	10 2	7.7	6.8	2 5	3.1	1.1	0

Table 19

Tahoe National Forest—1936 Deer Kill Records

Species - Rocky Mountain Mule Deer.

Total kill, estimated 580
Total measured 293

Antler classes—293 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	12	75	18	53	34	67	9	3	2	4	0	0	13	3
Antler classes, by per cent	4.1	25.6	6.1	18.1	11.6	22.9	3.1	1.0	0.7	1.4	0	0	4.4	1.0

Weight classes—74 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	1	0	3	2	5	6	9	7	6	6	8	3	7	11
Per cent, by weight classes	1.4	0	4.1	2.7	6.8	8.1	12.1	9.4	8.1	8.1	10.8	4.1	9.4	14.9

Diameter classes—293 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	30	51	70	41	42	23	19	9	1	6	1	0
Per cent, by diameter classes	10.2	17.4	33.9	14.0	14.3	7.9	6.5	3.1	0.3	2.1	0.3	0

Spread classes—293 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	1	6	26	42	20	28	33	35	42	20	17	13	6	4	0
Per cent, by spread classes	0.3	2.1	8.9	14.3	6.8	9.6	11.3	11.9	14.3	6.8	5.8	4.4	2.1	1.4	0

Table 20

Mono National Forest—1936 Deer Kill Records

Species—Rocky Mountain Mule Deer.

Total kill, estimated 150
Total measured 95

Antler classes—95 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	9	31	6	14	9	18	2	1	0	2	0	0	0	3
Antler classes, by per cent	9.5	32.6	6.3	14.7	9.5	19.0	2.1	1.0	0	2.1	0	0	0	3.2

Weight classes—31 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	0	2	6	2	3	4	6	1	1	2	1	0	3
Per cent, by weight classes	0	0	6.5	19.3	6.5	9.7	12.9	19.3	3.2	3.2	6.5	3.2	0	9.7

Diameter classes—95 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	21	14	24	21	9	2	3	1	0	0	0	0
Per cent, by diameter classes	22.1	14.7	25.3	22.1	9.5	2.1	3.1	1.1	0	0	0	0

Spread classes—95 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	1	11	21	3	12	13	13	7	8	3	2	1	0	0
Per cent, by spread classes	0	1.1	11.5	22.1	3.1	12.6	13.7	13.7	7.4	8.4	3.2	2.1	1.1	0	0

Table 21

El Dorado National Forest 1936 Deer Kill Records

Total kill, estimated 620
Total measured 136

Species—California Mule Deer.

Antler classes—136 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	4	40	13	30	14	22	3	1	0	1	0	0	5	3
Antler classes, by per cent	2.9	29.4	9.6	22.1	10.3	16.2	2.2	0.7	0	0.7	0	0	3.7	2.2

Weight classes—62 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	3	6	10	10	3	9	8	3	5	3	1	0	1
Per cent, by weight classes	0	4.8	9.7	16.1	16.1	4.8	14.6	13.0	4.8	8.1	4.8	1.6	0	1.6

Diameter classes—136 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	11	35	37	30	18	2	3	0	0	0	0	0
Per cent, by diameter classes	8.1	25.7	27.2	22.1	13.2	1.5	2.2	0	0	0	0	0

Spread classes—136 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	1	4	11	21	19	17	17	26	17	1	2	0	0	0	0
Per cent, by spread classes	0.7	3.0	8.1	15.4	14.0	12.5	12.5	19.1	12.5	0.7	1.5	0	0	0	0

Table 22

Stanislaus National Forest—1936 Deer Kill Records

Species—California Mule Deer.

Total kill, estimated..... 650
Total measured..... 400

Antler classes—400 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	15	151	37	66	38	57	8	3	1	1	0	0	17	6
Antler classes, by per cent	3.8	37.8	9.3	16.5	9.5	14.2	2.0	0.7	0.2	0.2	0	0	4.3	1.5

Weight classes—150 actual weights

Weight classes, dressed	50-70	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	7	12	19	15	23	21	14	13	10	13	5	3	1	0
Per cent, by weight classes	4.5	7 7	12.2	9.6	14.7	13.5	9.0	8 3	6.4	8.3	3.2	1.9	0.7	0

Diameter classes—400 measured

Diameter classes, by inches	.4-.7	.8-.9	1 0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1 8-1.9	2.0-2.1	2.2-2.3	2 4-2 5	2.6-2.7	2 8-2.9
Numbers, by diameter classes	53	129	94	75	38	10	1	0	0	0	0	0
Per cent, by diameter classes	13.3	32 3	23.5	18.7	9.5	2.5	0.2	0	0	0	0	0

Spread classes—400 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	4	12	39	62	57	66	48	46	31	18	9	5	2	1	0
Per cent, by spread classes	1.0	3.0	9.8	15.5	14.3	16 5	12.0	11 5	7 8	4.5	2.2	1.2	0.5	0.2	0

Table 23

Sierra National Forest —1936 Deer Kill Records

Species—California Mule Deer.

Total kill, estimated..... 1,600
Total measured..... 1,376

Antler classes—1,370 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. D.
Number, by antler classes	95	551	146	243	102	134	28	11	1	5	0	0	34	26
Antler classes, by per cent	6.9	40.1	10.6	17.7	7.4	9 7	2 0	0 8	0 1	0 3	0	0	2.5	1.9

Weight classes—131 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	0	6	17	15	14	14	15	12	10	12	4	2	6	4
Per cent, by weight classes	0	4.5	13.0	11.5	10.7	10.7	11.5	9.2	7.6	9.2	3.0	1.5	4.6	3.0

Diameter classes—1,370 measured

Diameter classes, by inches	.4- 7	8- 9	1 0-1.1	1 2-1 3	1.4-1.5	1.6-1 7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2 9
Numbers, by diameter classes	436	226	292	185	173	31	17	8	4	2	2	0
Per cent, by diameter classes	31.7	16.4	21.2	13.4	12.6	3.3	1.3	0.6	0.3	0.1	0.1	0

Spread classes—1,370 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	13	60	168	201	273	222	155	114	77	54	18	14	2	5	0
Per cent, by spread classes	0.0	4.4	12 2	14.6	19.8	16 1	11 3	8.3	5.6	4.0	1.3	1.0	0.1	0.5	0

Table 24

Sequoia National Forest—1936 Deer Kill Records

Species—California Mule Deer.

Total kill, estimated..... 1,200
Total measured..... 950

Antler classes—950 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	46	431	125	152	54	69	10	2	2	0	0	0	10	49
Antler classes, by per cent	4.8	45.4	13.2	16.0	5.7	7 3	1.0	0.2	0.2	0	0	0	1.0	5.2

Weight classes—63 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	6	9	14	7	3	8	7	1	1	2	1	2	1	1
Per cent, by weight classes	9.5	14.3	22.2	11.1	4.8	12 6	11.1	1 6	1 6	3.2	1.6	3.2	1.6	1.6

Diameter classes—950 measured

Diameter classes, by inches	.4- 7	.8-.9	1 0-1.1	1 2-1 3	1.4-1.5	1.6-1 7	1 8-1.9	2 0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	164	232	281	111	95	15	21	27	2	2	0	0
Per cent, by diameter classes	17.3	24.4	29 6	11.7	10.0	1.6	2 2	2.8	0.2	0.2	0	0

Spread classes—950 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	9	49	105	174	176	141	98	74	50	33	28	5	3	5	0
Per cent, by spread classes	0 9	5 2	11.1	18.3	18.5	14 9	1.03	7 8	5 3	3 5	2.9	0.5	0 3	0 5	0

Table 25

Los Padres National Forest—1936 Deer Kill Records

Species—California Mule Deer.

Total kill, estimated 1,000
Total measured 561

Antler classes—561 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	28	303	54	62	31	26	5	4	2	1	0	0	9	36
Antler classes, by per cent	5.0	54 0	9.6	11.1	5 5	4 6	0.9	0.7	0.4	0 2	0	0	1.6	6.4

Weight classes—221 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	22	23	37	34	35	24	23	11	6	5	1	0	0	0
Per cent, by weight classes	9 9	10 4	16.7	15.4	15.8	10.9	10.4	5 0	2 7	2.3	0.5	0	0	0

Diameter classes—561 measured

Diameter classes, by inches	.4-.7	.8-1.0	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	47	169	167	96	57	9	8	7	0	1	0	0
Per cent, by diameter classes	8.4	30.1	29.8	17.1	10.2	1.6	1.4	1.2	0	0.2	0	0

Spread classes—561 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	4	17	74	121	106	98	67	49	17	5	3	0	0	0	0
Per cent, by spread classes	0 7	3.0	13.2	21.6	18.9	17.5	11.9	8.7	3.0	0.9	0.6	0	0	0	0

Table 26

Angeles National Forest—1936 Deer Kill Records

Species—California Mule Deer.

Total kill, estimated 680
Total measured 661

Antler classes—661 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	60	399	63	60	17	16	1	1	1	0	0	0	7	36
Antler classes, by per cent	9.1	60.4	9.5	9.1	2.5	2.4	0.2	0.2	0.2	0	0	0	1.0	5.4

Weight classes—280 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	52	50	55	48	26	28	10	6	3	2	0	0	0	0
Per cent, by weight classes	18.6	17.9	19.6	17.1	9 3	10.0	3.6	2.1	1.1	0.7	0	0	0	0

Diameter classes—661 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1 1	1.2-1 3	1 4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	179	252	153	39	29	6	3	0	0	0	0	0
Per cent, by diameter classes	27.1	38.1	23 1	5.9	4.4	0.9	0.5	0	0	0	0	0

Spread classes—661 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	5	29	124	189	128	99	44	28	4	8	2	1	0	0	0
Per cent, by spread classes	0.8	4 4	18.8	28 6	19.4	15 0	6 6	4 2	0.6	1 2	0 3	0.1	0	0	0

Table 27

Inyo National Forest -1936 Deer Kill Records

Total kill, estimated..... 600
Total measured..... 219

Species—California Mule Deer.

Antler classes—219 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	14	84	26	37	21	16	4	2	1	0	0	0	7	7
Antler classes, by per cent	6 4	38.4	11 9	16.9	9.6	7 3	1 8	0 9	0 4	0	0	0	3.2	3.2

Weight classes—116 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	14	15	20	15	14	12	8	6	4	4	1	1	1	1
Per cent, by weight classes	12.1	12.9	17.2	12.9	12.1	10.3	6.9	5.2	3.4	3.4	0.9	0.9	0.9	0 9

Diameter classes—219 measured

Diameter classes, by inches	.4- .7	.8- .9	1 0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1 9	2.0-2 1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2 9
Numbers, by diameter classes	40	53	54	33	28	4	4	3	0	0	0	0
Per cent, by diameter classes	18 3	24.2	24 6	15.1	12.8	1.8	1.8	1.4	0	0	0	0

Spread classes—219 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	0	6	33	38	37	35	21	17	11	13	3	0	2	3	0
Per cent, by spread classes	0	2.7	15.1	17.3	16.9	16.0	9.6	7.8	5.0	5.9	1 4	0	0.9	1.4	0

Table 28

Inyo National Forest—1936 Deer Kill Records

Species—Inyo Mule Deer.

Total kill, estimated..... 300
Total measured..... 132

Antler classes—132 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	15	34	20	22	10	19	4	1	1	0	0	0	5	1
Antler classes, by per cent	11.4	25.8	15.2	16.7	7.6	14.4	3.0	0.7	0.7	0	0	0	3.8	0.7

Weight classes—17 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	5	5	1	4	7	11	4	1	4	0	4	1	0	0
Per cent, by weight classes	10.7	10.7	2.1	8.5	14.9	23.4	8.5	2.1	8.5	0	8.5	2.1	0	0

Diameter classes—132 measured

Diameter classes, by inches	.4- .7	.8- .9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Numbers, by diameter classes	11	32	40	24	13	7	3	2	0	0	0	0
Per cent, by diameter classes	8.3	24.3	30.3	18.2	9.8	5.3	2.3	1.5	0	0	0	0

Spread classes—132 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	1	3	15	18	17	14	17	19	7	4	8	5	2	2	0
Per cent, by spread classes	0.7	2.3	11.4	13.6	12.9	10.6	12.9	14.4	5.3	3.0	6.1	3.8	1.5	1.5	0

Table 29

Cleveland National Forest—1936 Deer Kill Records

Species—Southern Mule Deer.

Total kill, estimated..... 110
Total measured..... 85

Antler classes—85 measured

Antler classes, points	1 x 2	2 x 2	2 x 3	3 x 3	3 x 4	4 x 4	4 x 5	5 x 5	5 x 6	6 x 6	6 x 7	7 x 7	Odd	P. B.
Number, by antler classes	2	51	7	12	5	3	1	0	0	0	0	0	0	4
Antler classes, by per cent	2 4	60.0	8.2	14.1	5.9	3 5	1.2	0	0	0	0	0	0	4.7

Weight classes—61 actual weights

Weight classes, dressed	50-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200+
Number, by weight classes	4	4	10	12	9	13	6	2	2	2	0	0	0	0
Per cent, by weight classes	6 3	6.3	15 6	18 7	14 1	20 3	9 4	3.1	3.1	3.1	0	0	0	0

Diameter classes—85 measured

Diameter classes, by inches	.4-.7	.8-.9	1.0-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2.0-2.1	2.2-2.3	2.4-2.5	2.6-2.7	2.8-2.9
Number, by diameter classes	13	16	32	19	4	1	0	0	0	0	0	0
Per cent, by diameter classes	15 3	18 8	37.6	22.4	4.7	1.2	0	0	0	0	0	0

Spread classes—85 measured

Spread classes, by inches	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
Number, by spread classes	1	3	8	18	24	18	8	5	0	0	0	0	0	0	0
Per cent, by spread classes	1.2	3.5	9.4	21.2	28 2	21.2	9.4	5.9	0	0	0	0	0	0	0

PROGRESS REPORT OF TROUT HATCHERY EXPERIMENTS, 1938 [1]

By J. H. Wales and E. S. Lewis

Bureau of Fish Conservation
California Division of Fish and Game

The Mt. Shasta Experimental Hatchery is operated by the Bureau of Fish Conservation to determine ways and means for increasing the efficiency of the State hatcheries by improving trout foods, feeding methods and other hatchery practices. As a result of the experiments carried on here we hope to decrease the cost and increase the health of the trout fingerlings produced by the State. This hatchery, containing 24 troughs, is one of the five hatchery buildings located at Mt. Shasta.

The principal objects of the 1938 experiments were:

1. To determine whether it is absolutely necessary to keep trout hatchery troughs and attendant implements free from dirt and slime in order to have healthy fingerlings. In other words, is the scrupulous care usually employed in cleaning troughs as necessary as we have supposed? It is naturally desirable to avoid an unsightly accumulation of dirt and slime on the troughs and implements but we wanted to know if the fish would become sick if a middle course was followed. Could we, in short, sweep out the waste food and excrement from the troughs each day but not actually scrub off the slime and in so doing keep our fish in good health?

2. To continue our test of the practicability of feeding meal pellets to the fingerlings after they had reached a weight of 25 fish per ounce, as described in the progress report of the Experimental Hatchery for 1937. This test was made during the course of the experiment mentioned above.

Experiment to Test Desirability of Clean Troughs

Experimental Conditions

Loch Leven or brown, brook and rainbow trout fingerlings were used in these experiments as it was thought wise to determine if there was any species difference in resistance to unclean conditions.

The Loch Leven trout were from the Mt. Shasta Hatchery brood stock. Part were from the eggs of three-year-old fish spawning for the first time. The size of the eggs from these fish was 370 per fluid ounce. Part of the Loch Leven eggs were from four- to six-year-old fish and their size was 193 per ounce. The brook trout eggs were also from brood fish at the Mt. Shasta Hatchery. They averaged 627 per ounce.

[1] Submitted for publication, February, 1939. This is the fifth progress report of the experimental work carried on at the Mt. Shasta Experimental Hatchery. Previous reports were published in California Fish and Game: vol. 21, no. 2, pp. 110-124; vol. 22, no. 2, pp. 111-117; vol. 23, no. 2, pp.; 138-143; vol. 24, no. 2, pp. 126-132.

The rainbow or steelhead eggs were from the Klamath River and averaged 165 per ounce.

There were four troughs of Loch Leven fingerlings for part of the season; later the fish were spread into two more. The brook fingerlings were kept in six troughs for part of the season and later were spread into two more. The rainbow were kept in four troughs. At the start of the feeding, each trough of the larger Loch Leven had 23,800 fry; the troughs of smaller Loch Leven had 15,500 fry. The brook troughs contained 17,500 fry and the rainbow troughs each contained 20,700 fry. These loads were reduced during the season by thinning. The numbers of fish carried at all times were approximately the average for California hatcheries so that this factor was comparable to conditions in the average producing hatchery.

Half of each species was kept in well-cleaned troughs and cared for with well-cleaned instruments whereas the other half was kept in troughs purposely undercleaned. From February, when the eggs hatched, until June 15, the undercleaned troughs were swept out each day and scrubbed thoroughly once a week. From June 15 to the end of the experimental work on September 1, the undercleaned troughs were not scrubbed at all. The cleaned troughs were scrubbed with a paint brush each day.

The troughs were painted with aluminum paint, which, incidentally, has proven so satisfactory that all the hatchery troughs in the State are now painted with it. There is some evidence that aluminum painted troughs do not become coated with slime organisms as quickly as troughs painted with tank enamel. Slime on troughs is a thin layer of diatoms and other one-celled plants, together with bacteria and frequently protozoans. It is only natural that this slime growth is more abundant in some water than in others. The cause for this lies in the chemical make-up and temperature of the water. In the warmer trout waters the growth of slime is more rapid than in cooler waters. Just what chemical elements aid or hinder such growth are unknown but there is no doubt that in some hatcheries slime will grow more rapidly than in others. It may be that the conclusions of this experiment are more nearly applicable to the Mt. Shasta Hatchery than to the other hatcheries in the State. No doubt this is true but because conditions at Mt. Shasta are fairly typical, we may safely assume that these conclusions can be applied to the majority of California hatcheries. When evidence indicates a modification of the views expressed in the conclusions of this paper we should not hesitate to make them.

The water for the Mt. Shasta Hatchery comes from a large spring in the lava rock, two miles from the hatchery and flows through a natural gravel stream bed with considerable water cress for two-thirds the distance and then enters a dirt ditch by which it is conducted to the hatchery. The temperature ranges from 39 to 55 degrees Fahrenheit. The health of the fish at this hatchery is reasonably good. There are hatcheries in the State where more diseases occur and others where less trouble is experienced.

The food used has some bearing on the amount of slime developed. We have found in the past that when beef liver is fed, more slime is found on the troughs than when beef heart is used. Therefore we changed the food of all experimental fingerlings from beef heart after the first six weeks to beef liver. We should expect, therefore, that the uncleaned troughs in the experiment should develop at least an average amount of slime.

The brushes and nets used in the uncleaned troughs were not kept as clean as those used in the other troughs. This might be of some consequence in cases where an implement used in a trough containing diseased fish was not sterilized before it was used in other troughs, but under the conditions which prevailed in the hatchery during these experiments it is not surprising that we found no harmful consequence to using unsterilized instruments.

Results of Experiments

Briefly, the three species of trout fingerlings kept under both clean and relatively unclean conditions did not show any significant differences in mortality, occurrence of diseases or in growth.

Because the different groups of fish were thinned out once or twice during the season of approximately six months, it is impossible to give just one loss percentage for each group. Therefore in the following table is presented the various mortality percentages for the groups and periods.

Table 1

Mortality Percentages in Each Group of Trout, from One Thinning to Another, March-August, 1938

Species	Clean	Unclean	Clean	Unclean	Clean	Unclean
Large Loch Leven Trout	Mar. 27-July 1		July 1-Aug. 4		Aug. 4-Aug. 31	
	6%	5%	0.6%	0.5%	0.9%	0.9%
Small Loch Leven Trout	Mar. 27-Aug. 31					
	29%	20%				
Eastern Brook Trout	Mar. 7-July 1		July 1 - Aug. 3		Aug. 3-Aug. 31	
	37%	34%	1.4%	1.4%	0.6%	0.6%
Rainbow Trout	May 19-July 12		July 12 -Aug. 31			
	5%	4.6%	1.6%	2.1%		

The heavy losses shown for the first period in the eastern brook trout are due to dropsy disease or "bloat." In the small Loch Leven trout the initial loss is probably due in part to the fact that their parents were spawning for the first time, and partly perhaps to the cottonseed meal which the parent fish were fed. A more complete report

on adult brood fish feeding is planned for next year's progress report; suffice it to say that at this time there is some evidence to show that cottonseed meal may be harmful to the fertility of the eggs and vitality of young fingerlings.

Table 1 shows that in most cases of difference the uncleaned troughs of fish suffered a slightly smaller mortality than the cleaned troughs.

The growth of the different lots of fish under clean and unclean conditions was not significantly different. The cleaned and uncleaned lots in each group of fish were, of course, the same size at the start of the experiments. The lots were fed all the food they would consume without undue waste and they were thinned out equally whenever it became necessary to do so. Therefore the only difference in their care was the amount of cleaning their troughs received. It is not necessary to graph the growth of these different lots. They were essentially normal in this regard and the only figures which appear worthwhile are the sizes of the fish at the end of the experimental period on August 31.

The numbers of fish per ounce at the end of the experiment were as follows:

	Cleaned	*Uncleaned*
Large Loch Leven	15.5	16.0
Small Loch Leven	36.0	32.8
Eastern Brook	8.4	8.7
Rainbow	32.4	38.8

From this we can see that there was little difference in the growth of the cleaned and uncleaned lots of large Loch Leven and eastern brook. In the small Loch Leven the uncleaned trough produced the larger fish and in the rainbows the clean trough produced the larger fish.

The occurrence of diseases in these comparable lots of the different species is of course an important consideration. The small Loch Leven suffered a slight epidemic of fin-rot during August. The losses were small for the entire month. Out of approximately 13,000 in the cleaned trough only 95 were lost, and of the 13,000 in the uncleaned lot only 130 died from all causes. The eastern brook suffered considerably during March from dropsy disease. On March 5 there were 52,500 fingerlings in the uncleaned lot and a similar number in the cleaned lot. During March, 12,482 in the cleaned lot and 11,745 in the uncleaned lot died. It does not seem probable that this difference is correlated with the cleanliness of the troughs. In this disease there is always great variation in mortality in different troughs of young brook fingerlings and the probability is good that this difference in loss is due more to chance than to the cleanliness of the troughs. The rainbow fingerlings in the uncleaned lot developed some Octomitiasis in August and the loss in this trough during the month was 359 as contrasted to 206 in the cleaned lot. There were 25,875 fish in each of these lots at the first of the month. It seems possible that there is some correlation here

between cleanliness and incidence of the disease but at present it is not clear just what the connection might be.

We see, then, that the evidence, though rather confusing in some respects, indicates that cleanliness does not play an important part in the occurrence or severity of disease. Of course the troughs which were not scrubbed daily actually were not conspicuously dirty. In fact one would have to touch the trough walls to be sure which were coated with slime and which were clean. A noticeable accumulation of decaying food and excrement in the troughs might have a more evident effect on the health of trout, but as this situation never occurs in California hatchery troughs it was not thought necessary to produce an abnormal condition experimentally.

Pellet Feeding Experiment

As pointed out in last year's progress report, the use of pellet type food for adult fish is not uncommon but the feeding of pellets to fingerlings in troughs is not of such widespread occurrence. There is nothing difficult about making pellets for small fish. Briefly, the procedure is to select the meals thought nutritionally advisable and secure a fine grade of each. Almost any meal or combination of meals will work, providing they are fine enough. However, dry milk should not be used in the powdered form as it tends to pack and form hard pellets. The flake type of milk is much more desirable. We used finely ground vacuum dried sardine meal and flake dry milk in the proportion of fifty-fifty. A small amount of water is added and mixed thoroughly by hand or machine until the meals are moderately damp. Then the combination is ground through the finest plate of the meat grinder, which is approximately 5/64-inch. The resulting strands of meal can be broken up by hand into short lengths and scattered to the fish like feeding grain to chickens. When properly made the pellets are soft and can be easily broken up by the fish. A few days of such feeding are necessary before fingerlings become accustomed to them and we have found that brook trout and rainbow will eat them more readily than Loch Leven. We find that fish smaller than 25 per ounce can not eat pellets made through the 5/64-inch plate. Of course, these meal pellets must be supplemented with fresh meat, preferably liver. It is not possible to use sufficient liver in the pellets when made small enough for fingerling trout so we feed pellets twice a day and liver once. This combination has given us just as fine fish during the last two years as straight liver has and at a lower cost.

Summary

1. The principal object of these experiments was to determine if trout hatchery troughs needed to be scrubbed free of their slime coat each day (or frequently) in order to keep the fingerlings in good condition.

2. The feeding of meal pellets to fingerlings larger than 25 per ounce was tried for a second year.

3. Loch Leven, brook and rainbow trout fingerlings were used in these experiments, starting with the eggs and carrying them until September, by which time the California trout fingerlings have customarily been planted.

4. Each species was divided into two lots, one kept in troughs scrubbed free of their slime coats each day, and the other lot kept in troughs which were swept clean of food and excrement but not cleaned of the slime coat.

5. It was found that there was no great difference in the mortality of the contrasted groups nor in their growth. The amount of disease in the various lots is somewhat confusing, though the writers do not feel that the uncleaned lots suffered significantly more than those kept in the clean troughs.

6. We may conclude therefore that under the average hatchery conditions it is not necessary to keep the troughs free from the slime coat. However, it may be possible that under some conditions diseases can be promoted by slime organisms. The subject is not closed but we feel safe in saying that the presence of slime on hatchery troughs is not as dangerous to the health of the trout fingerlings as is often believed.

7. The feeding of meal pellets twice a day and liver once a day to trout fingerlings was proven again to be a satisfactory and economical method of feeding.

CAN THE SUPPLY OF SARDINES BE MAINTAINED IN CALIFORNIA WATERS?[1]

By FRANCES N. CLARK

California State Fisheries Laboratory
Division of Fish and Game

The possibilities of maintaining an adequate stock of sardines in California waters have been discussed by research investigators and administrators for many years. The declining abundance of this all-important fish has been evident to the observant student and the alert fisherman for the past eight to ten years, but only in the past two seasons has the fact been forced to the attention of the entire industry. In 1937-38 fishing was so difficult that all admitted the immediate scarcity of fish but many still failed to realize that 1937-38 represented the climax of a decline in abundance that had been going on for some time. In the present season, 1938-39, fishing conditions are better but, as realized by everyone, only because a fairly numerous group of young fish are just entering the fishery. Larger sardines are still difficult to find and the present intense fishery for these small fish will give them no opportunity to grow to larger and more useful sizes.

To decide how best to meet the situation it is necessary to determine how the present scarcity has come about. This question is discussed in detail in a recent publication issued by the Division of Fish and Game[2] and the following constitutes a brief summary of that report. The first and most important step is a consideration of the number of fish in the sardine population. Man has not yet devised a way to count the numbers of fish in the sea but he has set up certain yardsticks to measure the relative number from year to year.

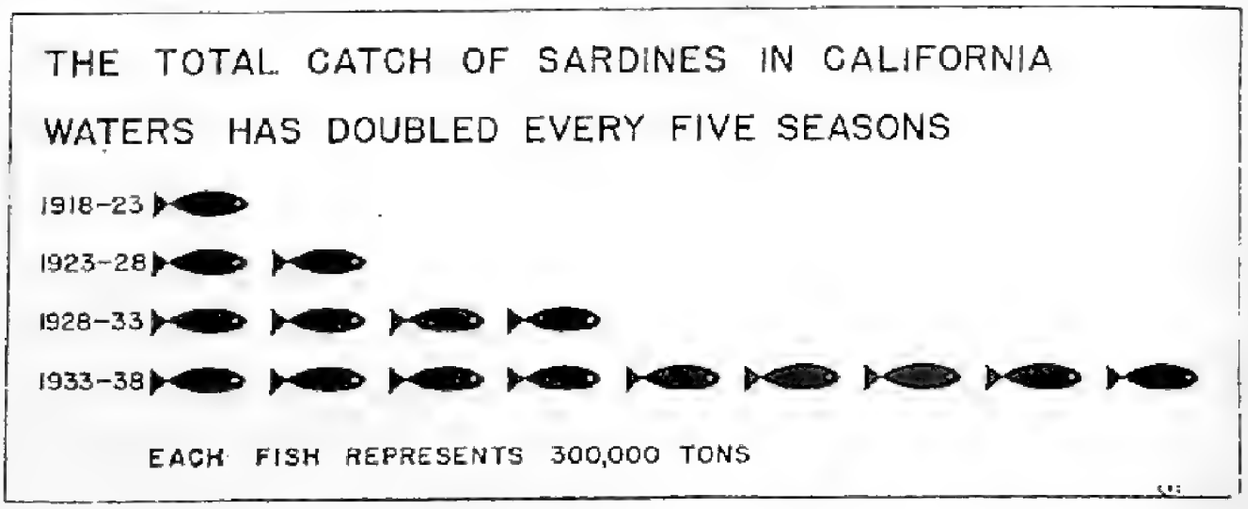


FIG. 72.

[1] Submitted for publication, January, 1939.

[2] Clark, F. N. Measures of abundance of the sardine, *Sardinops caerulea*, in California waters. Calif. Div. Fish and Game, Fish Bull., no. 53, 1939.

Nearly all of these yardsticks are based on the fishermen's catch, so what of the total take of sardines over the past two decades? Like many of our California fisheries the sardine industry experienced its initial boom during the World War. Since that time, 1918, twenty years have elapsed and in that interval the total catch of sardines has doubled every five seasons. The effect that this rapid expansion has had on the sardine population is more readily understood if we assume that at the beginning the fishermen took 5 per cent of the population each season. During the next five years they would have taken 10 per cent, then 20 per cent and finally 40 per cent. Perhaps 5 per cent is more than was actually taken in 1918 but the catch could not have been much less, and it is obvious that the total catch can not again double in the next five-season interval. That it can increase at all is doubtful and whether the catch can be maintained at its present level depends upon how much the present catch is annually taking from the population.

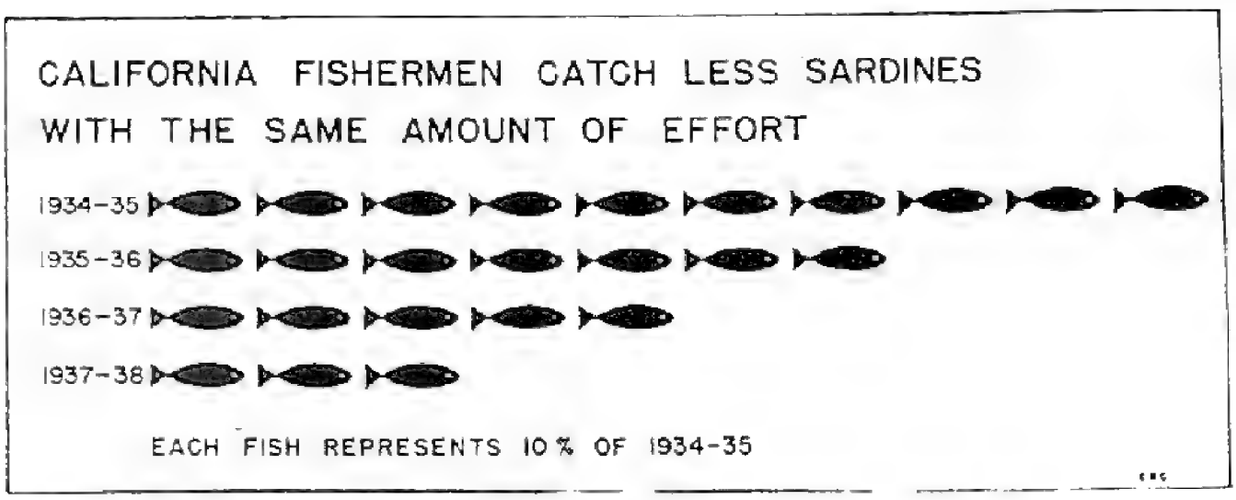


FIG. 73.

One of the yardsticks used to tell how well a fish population is standing up to the fishing strain is to determine if the fishermen continue to get as much fish for the same amount of effort as in former years. The total catch may increase because more fishermen are fishing and because each fisherman works harder, but if for the same unit of work, the fisherman catches less it means that the population is being fished out faster than it is being rebuilt by nature. In California the average monthly catch of individual fishing boats has fallen off consistently for the past four seasons. In 1937-38 the average month's catch of the individual boats was but 30 per cent as large as in the 1934-35 season. This means that formerly one boat could catch in the same time interval more fish than three boats now catch. Obviously, the sardine population is decreasing in numbers at a serious rate.

Again if a fish population is in a healthy condition, each generation of fish will live as long as former generations lived. On the other hand, when fish are being caught more rapidly than nature can make replacements, the older and larger fish become scarcer. Because

there are fewer older fish the fishery takes more and more younger fish and the life expectancy of each generation becomes less. The same thing happens to a human population when a nation wages war for a long term of years. As all the able bodied men are killed, younger men and even boys are conscripted into the army and the chance of a boy growing to middle age decreases year by year. For the sardine during the first of the two decades we are considering, the adult life expectancy of a sardine generation was approximately 10 years. In the next five years it decreased to six years and at present it is probably not more than four years. This means that our sardine fishery is now catching the larger fish much more rapidly than they are being replaced by nature.

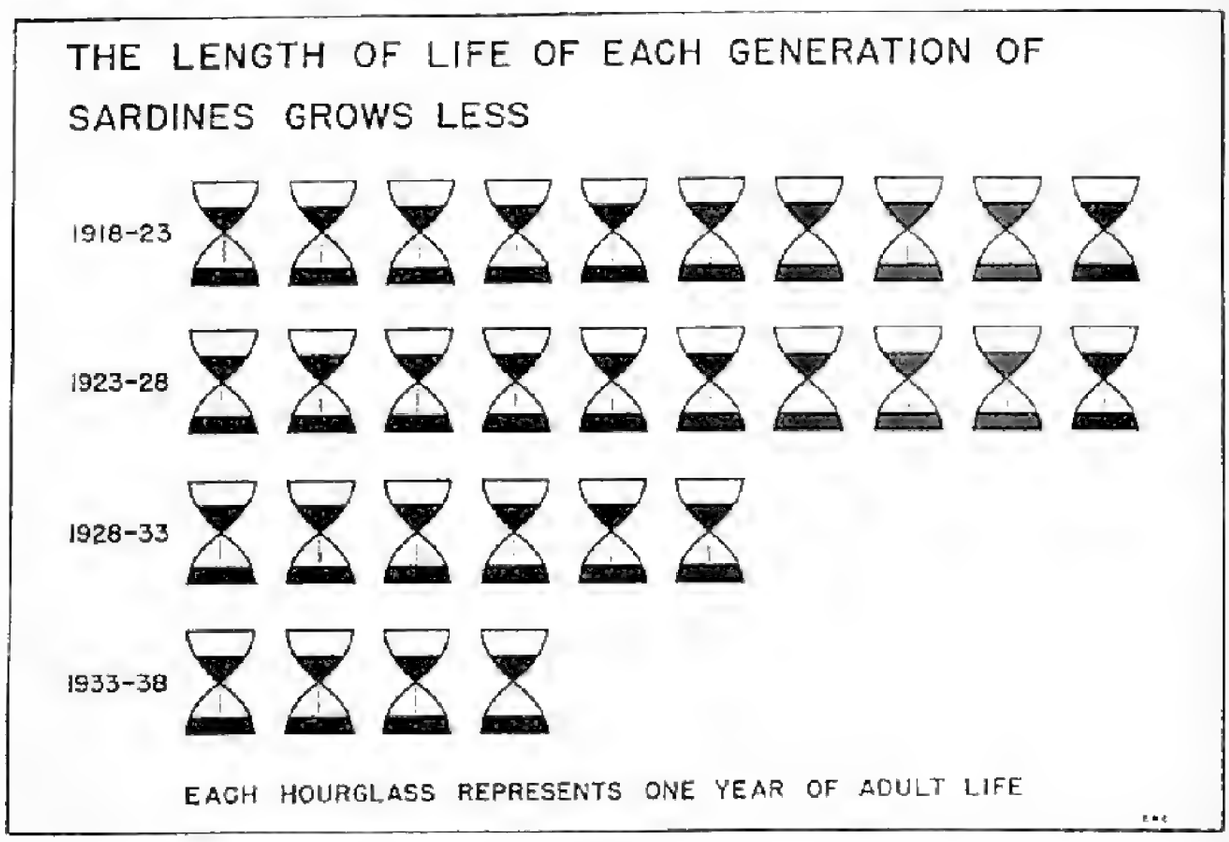


FIG. 74.

Another manifestation of the increasing scarcity of sardines is the vast extension of the fishing grounds. To supply the present demand the sardine fleet is cruising over most of the coastal waters from Point Arena, one hundred miles north of San Francisco, to the Mexican boundary and out to and beyond the Channel Islands.

If we are willing to accept the evidence we must admit that the California sardine population is now at a low level of abundance, but what can be done to stop the decline and to build the numbers of fish back to something like their former magnitude? The only constructive move is to decrease the total season's catch, but how much should this decrease be and how can it best be accomplished?

The number of sardines which we can take safely from the population each season is indicated by the life expectancy of the sardine. During the ten seasons from 1918 to 1928 the adult life span was about

ten years. In that time interval the catch from California waters showed a year by year increase but no season's total catch reached 200,000 tons. In the next five years the catch continued to increase and in one season went over 300,000 tons. With this increase in the magnitude of the catch the adult life span of the sardine dropped to about six years. Again in the succeeding five seasons, the total catch continued to increase and in 1936-37 reached an all time high of over 700,000 tons. At the same time the adult life span of the sardine dropped to four years or perhaps less. It is evident that with a healthy sardine population a catch of 200,000 tons placed no undue strain on the supply and that a 300,000-ton catch was on the borderline of being too great. With favorable natural conditions for replacement the sardine population could probably withstand a seasonal take of 300,000 tons but when nature is less kind the replacements can not make good an annual fishing loss of 300,000 tons. A seasonal take of over 300,000 tons can not be considered except perhaps for those rare limited periods when nature has produced exceptional spawning survival. But we must remember that a safe annual take of two to three hundred thousand tons occurred when the sardine population was in a healthy condition. At that time the California Division of Fish and Game suggested an annual limit of 250,000 tons. If the industry had given heed then it would have been in a much happier condition at present. Now the population is much decimated and for the next few years the seasonal limit probably should be less than 200,000 tons and thus a surplus would be built up more rapidly. As the numbers of sardines again increase, the total catch can be increased but always the relation of total catch to the total sardine stock must be carefully balanced.

Having decided on the magnitude of the season's catch, how can the reduction be brought about most readily? The interests of the industry should largely determine the procedure. The most satisfactory method would be to have all the plants of the State agree on how the season's total shall be divided among them. Such an agreement, however, is fraught with difficulties and some other method may have to be found. Because the rapid expansion of the industry came with the granting of permits for using sardines for straight reduction to oil and meal, an alternative method would be to rescind all reduction permits. Unless the market for canned sardines expands greatly such a move would probably hold the total season's catch to a safe limit.

Closed seasons have not proved expedient for as soon as the season is opened the industry operates with increased intensity and takes as great a total as before. Closed areas will give little protection to the sardine population for it is a migratory fish moving freely from area to area. Because of the nature of the fishery, a size limit is not feasible. Round haul nets take all sizes of fish and it would be very difficult for fishermen to avoid schools containing some or even a fair proportion of undersized fish. A fixed mesh size which would theoretically allow undersized fish to escape would be disastrous because a large proportion of fish near the legal size limit would gill and make the operation of the nets impossible.

If the supply of sardines is to be maintained in California waters, some regulatory measure must be adopted. A fixed total season's catch for the entire State would be the fairest to both the canning and reduction phases of the industry. For the immediate future this total should not be greater than 250,000 tons or about half of the present catch throughout the State. The industry should determine the method of allotment. An alternative method of regulation is to prohibit the use of whole sardines for reduction purposes.

THE PISMO CLAM IN 1938[1]

By PHIL M. ROEDEL

California State Fisheries Laboratory
Division of Fish and Game

The Pismo clam (*Tivela stultorum*) was at one time exceedingly abundant on all of the sandy beaches of California from Half Moon Bay south. It was so very abundant throughout its range that the supply seemed ample for all. However, thousands of amateur diggers plus commercial men have, in the course of the years, stripped off the bulk of this population until today Pismo clams are found in numbers on but few of our beaches, and on them in nothing resembling their former abundance. Pismo Beach is one of those still supporting a clam fishery, and it is there that the California State Fisheries Laboratory has, since 1919, carried on a study of this species.

At present, this work consists of making an annual census of the clam population. The census is made by digging three trenches, each 15 centimeters in width, across the intertidal zone at the same locality each year. All clams found are taken to the Laboratory where the number, ages and sizes are carefully recorded. Then all surviving clams are replanted on a nearby southern California beach. Of the three trenches, two are made at widely separated places on that portion of the beach open to digging while the third is made in the area closed to digging in 1929. The census is always made in late fall or early winter after the previous summer's set of young clams is firmly established.

The 1938 census, made December 6 to 8, was marked by several features, none of which offers encouragement to those interested in the conservation of this species. But 548 clams were found in the three standard sections, a drop in number of over 50 per cent from 1937, and the fewest found since 1934. The decrease was most marked in the closed area, where the number of spawning and legal-sized clams proved to be greatly reduced. ("Spawning" clams are regarded as those with four and more winter rings; actually, some two- and three-year-olds do spawn.) Lack of a 1938 set and a poor survival of the 1937 set were other salient features.

The set for 1938 is, as noted, almost nil. Only nine clams of that group were found in the three sections. This poor set following the good one of 1937, is in line with the trend of the sets since 1928, namely that relatively good sets have occurred in alternate years. This variation in size of set from year to year is shown in figure 75. It will be noted that the 1933 set, while far better than those in 1932 and 1934, is but little better than the "poor" set of 1936 and far below that of 1930. Prior

[1] Submitted for publication, December, 1938.

to 1928, only two good sets appeared in the ten years for which we have data. In 1919, an enormous number of young clams was found, while a moderate set occurred in 1924.

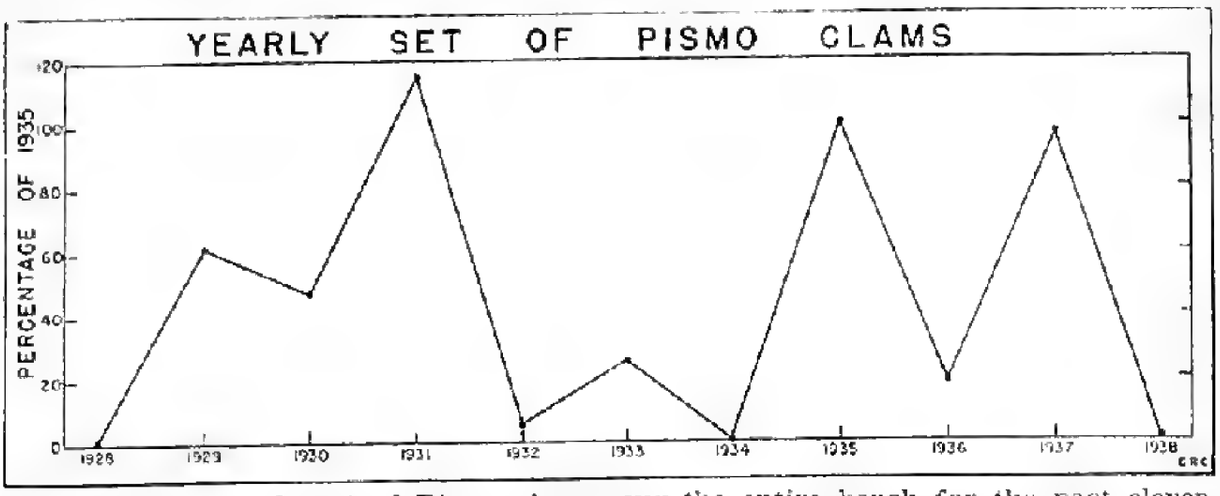


FIG. 75. The yearly set of Pismo clams over the entire beach for the past eleven years. The number of clams found in the 1935 census is regarded as 100 per cent and the numbers found in other years are expressed as percentages of that. Between 1919, when the first census was made, and 1928, but two good sets were noted: an exceptionally large one in 1919 and a moderate one in 1924.

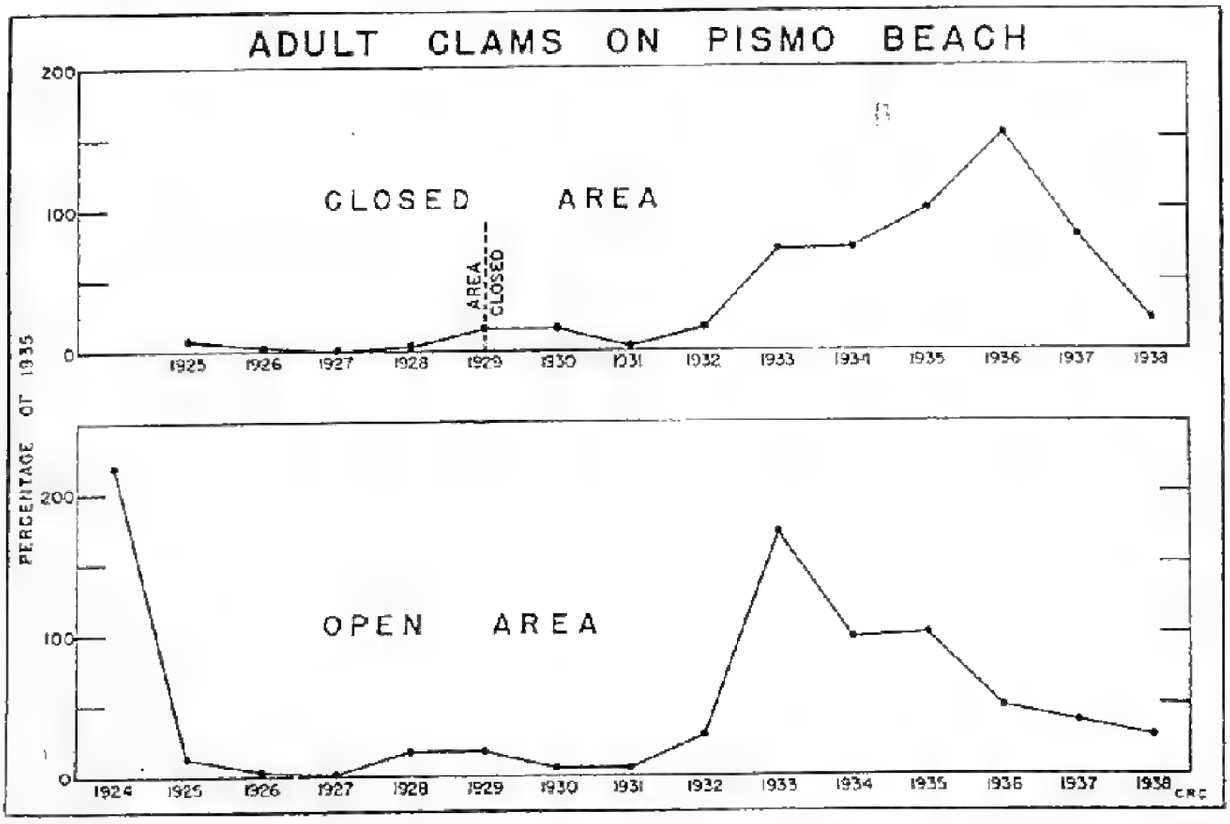


FIG. 76. The number of adult clams expressed as a percentage of the number found in 1935, on the open and on the closed areas of Pismo Beach since 1924. Clams four years and older are regarded as adult. The first census in what is now the closed area was made in 1925. The most notable feature shown by the graphs is that the succession of good sets since 1928 has had but a passing effect on the number of older clams. Even in the closed area, where the number increased for several years, there are now but few more clams than there were in 1932.

Something of a decrease in the number of spawning clams on the legally open beach was not unexpected in 1938. In this area, clams are removed as soon as—and, unfortunately, frequently before

—they reach the legal size of five inches. Clams of the small 1934 set, spawning for the first time in 1938, contributed little to the adult population, while the bulk of the clams already of spawning age had reached legal size and had been taken by the diggers. It was in the closed area that the drop was great and unexpected. There the number of older clams in the population steadily increased from 1931 to 1936. (Digging was prohibited on this part of the beach in 1929, the year of the first exceptionally good set since 1919.) In 1937, however, there was a considerable drop, and the 1938 census shows an even greater fall. Actually, the relative decline has been larger on the closed area than it has been on the open beach, for we find but 21 per cent as many spawning clams in the closed area as in 1935, compared to 27 per cent on the open area. Likewise, clams of legal size in the closed area show a pronounced decrease both in number and in the proportion they comprise of the total population of the area. The drop in number of older clams can not be accounted for by the lack of four-year-old clams plus a normal death rate. The only answer is, as it has been in the past, removal of clams from the closed area by man.

In figure 76, the changes in the population of adult clams are depicted graphically for both open and closed areas. It is noticeable that the huge 1919 set maintained a fair stock until 1925, when it was practically wiped out. The clams were then in their sixth year. On the other hand, the 1924 set, the only one even moderately good between 1919 and 1929, added little to the number of adult clams in 1928 and 1929, when the clams were in their fourth and fifth years. After 1932, the influence of the good sets following 1928 became apparent, and in 1933 the open area reached its most prosperous stage since 1924. But since then the trend has been steadily downward and despite the good sets there now appear to be but few more old clams on the open beach than there were in the lean years of the twenties. In the closed area the outlook was encouraging until 1936. Between 1932 and 1933 it enjoyed a greater relative increase of older clams than did the open area. Year by year the number of adult clams steadily increased and the hope of a replenished supply grew bright. Now in two years' time we find the beach stripped down to a point little better than it was when the refuge was established.

The serious condition of the clam population is further emphasized by the mortality rates since 1919, the first year for which figures are available. (See Fig. 77.) That diggers are taking more and more young clams each year is strongly indicated. For convenience, the data from 1919 to 1933 has been grouped in five-year intervals. Data for the following period, 1934 to 1937, is necessarily incomplete. In figure 77, the "0" group—the number of clams less than one year old at the time of each census—is regarded as 100 per cent, and the numbers found in succeeding years expressed as a percentage of the "0" group. Data for the 1919-1923 and 1924-1928 curves is drawn from Clark (California Fish and Game, vol. 18, p. 170, 1932). We note that in the first five-year period, 1919-1923, survival was good until the clams reached their third to fourth year. The greatly increased mortality during the third to fourth year indicates that even prior to

1923 poaching was prevalent, as the size limit, then 4¾ inches, should have protected clams of that age. The 1924-1928 curve indicates that smaller and smaller clams were being removed from the beach; clams of about two years were being taken. In the 1929-1933 period, the situation approached its ultimate development and clams a year old were fair prey. The figures for 1934-1937 may indicate a somewhat lessened attack on the very young clams, though the difference is so small that it could be a chance happening. Actually, the figures show an excellent survival of clams of the relatively poor 1936 set, and a high mortality among the 1935 and 1937 sets. The culmination of this trend can spell only disaster. It is well to remember that many southern California beaches once had large populations of Pismo clams but to find one lone clam today, for example, at Long Beach, is indeed uncommon.

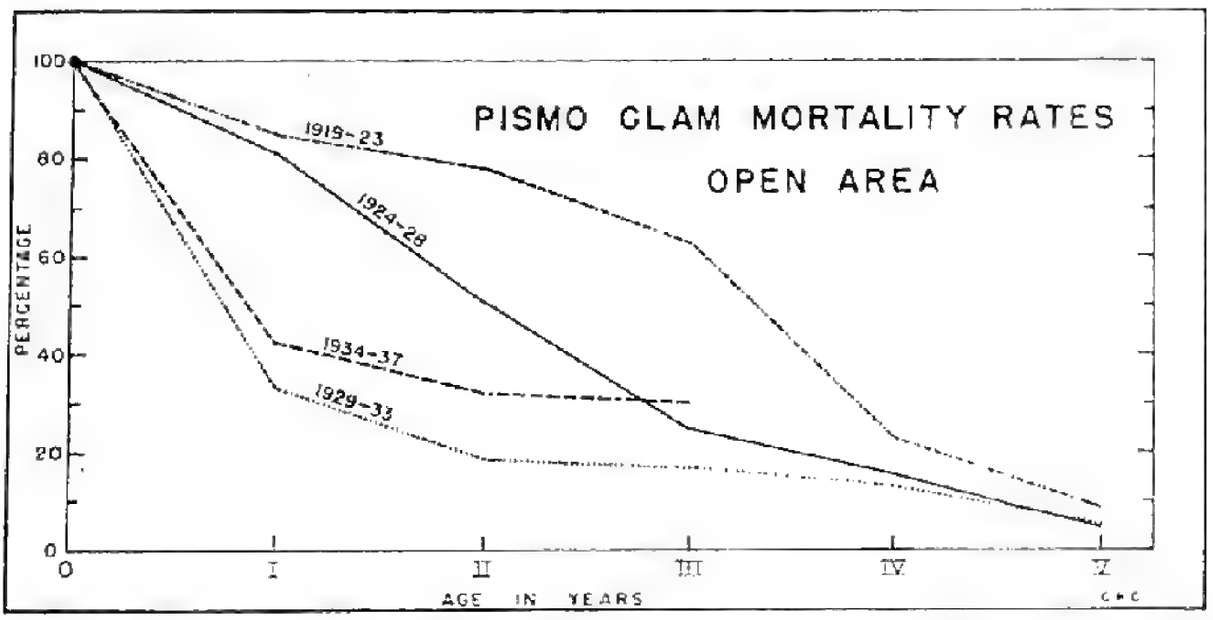


FIG. 77. Mortality rates of Pismo clams in the open area of Pismo Beach. The number of clams less than a year old at the time of each census is regarded as 100 per cent and the numbers of each year-class found in the following years are expressed as a percentage of that number. Data for 1919-1933 has been combined into five-year groups for clarity of presentation. A much higher mortality among clams one year old is evident since 1929 than was the case in earlier years.

In summation, we may say that the condition of the clam population on Pismo Beach has not been materially improved by the succession of good sets since 1929 and that the trend is, if anything, for the worse during the past two years. This comes despite improved protection through a closed area and augmented patrol work. At present, there are many small clams on the beach, representatives of the 1935 and 1937 sets. However, if they are removed from the beach before they have had a chance to spawn several times, *i.e.*, until they reach the legal size limit of five inches, they can do little more than hold the beach at its present low rate of productivity. It is notable that commercial diggers are turning their attention more and more to the Morro Bay area as they simply can not find enough clams on Pismo Beach either to meet the demand or to make a living.

Much of the blame for the depletion of the clam must rest on the shoulders of the tourist digger. While one group of visitors to the beach may itself take but a few small clams, the thousands of other similar groups likewise engaged, between them remove huge numbers.

Indifference of the local residents toward the status of the beach is a major factor. If this public apathy toward conservation was instead public support of the efforts of the California Division of Fish and Game, much more would have been, and could still be, done. But compared to the other resources of the State, the Pismo clam is of very minor importance, and the Division can not be expected to throw additional effort into the matter at the expense of other fisheries, as long as those most intimately concerned either do not care what happens or themselves take an active part in poaching in the closed area and in removing small clams in the open.

Laws which have been in effect during past years would have been sufficient to protect the clam population had they been observed. Because conditions are now very serious, additional laws and restrictions may be advisable but they will be of no more avail than have those of the past if the traditional attitude is maintained. Local support of the legal measures is essential if the Pismo clam is to continue as one of California's outdoor assets.

EDITORIALS AND NOTES

VOLUME 25 APRIL, 1939 Number 2

CATTLE AND FISH

We do not think of a cattleman as a typical conservationist. Our picture of him, possibly our motion picture of him, involves a large hat and two six-shooters. By contrast, the conservationist wears a white collar and an air of high ideals and altruistic sentiment. He deals in big words rather than in cattle. We think of one as practical and the other as visionary and we are correct in assuming that the cattleman is in business to make money, not to make the world safe for sentiment. However, we are wrong if we assume that practical money-making is different from conservation because conservation is the principle of management under which certain kinds of business are handled so as to make more money than under any other plan of management.

Not in spite of, but because of, his desire to make money, the cattleman is a good conservationist and his practical nature leads him to apply conservation in his everyday business. He is in the business of managing the production from a natural resource. The land grows grass and the range is stocked with cattle to harvest the grass and to grow a cattle crop. Cattle reproduce, so the herd is operated on a continuous basis yielding a regular annual harvest. The number of head of cattle sold each year is regulated to roughly equal the average yearly calf crop so that the range may remain continuously stocked with all the cattle it can comfortably carry. That plan of management insures a larger annual harvest of cattle continuously than is possible under any other plan of management. To be sure, a larger cattle crop could be harvested for two years by selling off half the herd each year, but under that plan the breeding stock would be gone in two years and there would be almost no crop at all the third year and thereafter. The most money is made by operating the range on a continuous yield basis with a full growing stock of all the range will carry. That plan insures the greatest possible annual harvest. That plan, over a period of years, enables the range to produce more salable cattle than is possible under any other system of management. That is conservation applied to cattle growing.

Superficially, fish are not just like cattle. Fish do not bog down on the wet range till they have to be tailed up onto their feet again, and they sometimes graze on each other as well as upon the plants of the range, but they do stray over a given range, reproduce, and part of the herd is corralled and sold each year. Under a businesslike management, the range boss regulates the annual crop so as to keep a full breeding stock on the range, thereby insuring a large calf crop each

year and making available the largest possible annual harvest year after year. Management of a fully stocked range on a continuous yield basis produces the best crops, whether the stock be cattle or fish. The application of the principles of conservation to the management of marine fisheries has an imposing sound, but it means handling the herd to get the best continuous crop.

The citizens of California are the owners of the fish along the coast of this State, and the Division of Fish and Game has been appointed by the owners to act in the capacity of range boss. The owners specify that the range is to be managed on the Conservation Plan, that is, the harvest is to be regulated so as to insure a maximum continuous yield. The ocean range is being so managed but not with complete success in all cases, chiefly because some of the owners want too large an annual harvest, not realizing that the breeding stock on the range is thereby seriously depleted and that future yields inevitably will be cut down to a point far below what they should be. It is sometimes hard to see the dollar behind the nickel. Not all the owners of the fish use as good judgment as do the cattlemen, but the majority of the owners prefer a businesslike management of their property and consequently the range boss of the fish in the ocean, with the support of the more practical owners, can report many successes in range management along with some partial failures.

Running a herd of fish on the ocean range offers some difficulties. For example, an exact nose tally of the stock on hand is almost impossible, so the number of head on the range at any one time must be approximated rather than actually counted. It is correspondingly difficult to tally the calf crop each year. Drift fences in the ocean would be expensive and the movements of strays are hard to follow under the water. However, migrations may be learned by branding some of the stock, the tally of breeding stock and calves can be approximated, and the annual crop harvested can be recorded with exactness. The cattlemen have accumulated so much knowledge about cows, the carrying capacity of various areas, the acres necessary per cow, the normal calf crop per hundred head, and the results of past years' operations, that future yields from each area can be predicted with considerable certainty. There is a comparatively scanty accumulation of knowledge about the ocean and its fishes, but the information needed for proper management of the fish supply is being acquired as rapidly as possible.

The Bureau of Marine Fisheries employs a staff of trained investigators to furnish the needed information about the supply of fish and their movements and habits. Basically the management of ocean fish requires about the same kind of knowledge as is needed by the cattlemen, that is, the stock on hand, the annual sales and the replacements by the calf crop.

Much of this information about our herds of fish is being supplied but only part of it is being applied. In the early days of America, the herds of buffalo were thought to be inexhaustible, and now some of us are still bedevilled by this illusion of inexhaustibility in spite of the fact that several of our greatest ocean fisheries have already been exhausted in California and others are following along the same trail.

Bitter medicine is always unpleasant and we don't like to admit we are killing the goose that lays the golden eggs. We like to profess the principles of conservation for that makes us feel idealistic and altruistic, but actually we could do with less sentiment about our natural resources. We need more facing of the facts and the direct application of the cattleman's common sense business management.—*W. L. Scofield, California State Fisheries Laboratory, January 1, 1939.*

SEATTLE HALIBUT BOATS CATCH MONTEREY SHARKS

Early this year the hardy halibut fishermen of the North Pacific invaded the Mediterranean-like port of Monterey. The blonde, blue-eyed men although quiet in manner are conspicuous among the darker Italian and Sicilian fishermen. Their boats, too, with straight stems, high freeboard, and gaff-rigged masts are quite different from the smaller Monterey-type market fishing boats with wide-flaring clipper bows and fan-tail or compromise sterns.

The first appearance of these boats at Monterey was in January, 1939. Since that time, a half dozen of these boats have visited this port, with four here at present. The visiting halibut boats range from 45 to 60 feet in length, and a typical one would be 57 feet long with a capacity of 26 tons net, and powered with a 75-horsepower diesel engine.

The northern halibut fishing gear is being tried out on our sharks, as a sort of vacation experiment, while the season is closed for halibut in Alaskan and British Columbian waters. The regulation halibut fishing gear being used consists of long lines anchored at both ends. A buoy and bamboo pole marker are attached to the anchor by a line. Under ideal conditions of weather and bottom, a string nearly seven miles long with approximately 2400 hooks in one set will be laid out. More often the strings are broken up for convenience into smaller units. For shark fishing there is a crew of five, two less than a regular halibut crew.

Because the halibut boats are bigger and more sea-kindly than the local market boats, their crews have been able to work successfully under conditions that kept the local shark fishing boats in port. As a result they have roamed far and wide, prospecting for sharks from Half Moon Bay to Point Conception, and making sets in depths ranging from 15 to 250 fathoms on all types of bottom. Some of the skippers like shark fishing so much they are planning to return next winter after the close of the halibut season in November.

All the local shark boats use gill nets although set lines are used in San Francisco Bay.—*Robert D. Byers, California State Fisheries Laboratory, February 15, 1939.*

MONTEREY PURSE SEINERS EXTEND FISHING AREA

The scarcity of winter fish during the 1938-1939 sardine season forced Monterey purse seiners to extend their fishing grounds as much as 70 miles south of this port. Several loads were delivered from the vicinity of Piedras Blancas, 45 miles beyond Pfeiffer Point, the most southern fishing area in former seasons.

When fishing was resumed after the full moon in January, large schools were discovered between Half Moon Bay and the Farallone Islands, traveling southward. The fishermen worked these schools until they reached Point Sur, the usual southern boundary of the fishing grounds, but since no other schools had been discovered to the north they continued following the same fish south to Piedras Blancas. Several days of rough weather at the time prevented the seiners from continuing any farther south. The bulk of the sardines landed here this year came from between Pigeon Point and Point Sur, and within three miles from shore. The extreme northern and southern limits for the Monterey boats are to date the Russian River and Piedras Blancas, respectively, and the fishing grounds for the Monterey fleet now extend along approximately 200 miles of coast line, from 130 miles north of Monterey to 70 miles south.—*Robert D. Byers, California State Fisheries Laboratory, February 17, 1939.*

REVIEWS

The Bird Life of Louisiana

By Harry C. Oberholser; foreword by William G. Rankin. Louisiana Department of Conservation. Bulletin, no. 28, 834 pp., 45 figs., index, 1938.

This book by Dr. Harry C. Oberholser, Senior Ornithologist of the United States Bureau of Biological Survey, was prepared for the Department of Conservation of the State of Louisiana as a part of its educational program. Dr. Oberholser has gathered together into this one volume all the hitherto published and unpublished data relating to the birds of that State.

"Bird Life of Louisiana" is apparently not intended to serve as a guide to the identification of birds in the field. In most cases the descriptions are inadequate and few actual measurements are given. The book is replete, however, with interesting notes on the life histories and habits of Louisiana's avian visitors and the records of occurrence of each species are presented in detail. The "Calendar of Bird Migration in Louisiana" and a short introductory chapter dealing with the subject of migration in general, are particularly fine. The calendar gives the dates of arrival and departure of most of the migrants at both New Orleans and Monroe during both the spring and fall migrations. The book also includes an excellent bibliography of Louisiana avifauna.

The illustrations are a series of photographs of birds in their natural habitats together with eight color plates by Major Allan Brooks, R. Bruce Horsfall and George M. Sutton. The frontispiece, painted by Mr. Sutton, depicts the Ivory-billed Woodpecker, one of the rarest of North American birds.

This book will be of interest to any student of ornithology.—*Gordon H. True, Jr., California Division of Fish and Game.*

The Nation's Forests

By William Atherton Du Puy; introduction by F. A. Silcox, Chief, U. S. Forest Service. New York, Macmillan Co., 1938. 261 pp., illus., index. $3.00.

Tastefully bound and beautifully illustrated is this concise, well-organized account of our National forests. The subject is covered thoroughly and one gains the distinct impression that the author—not a Forest Service man, but a scribe by profession—received a thorough, though perhaps brief, Forest Service training before he buckled down to the task of writing about its activities.

In his first chapter, "Everyman's Forest," the author attracts the instant attention of his readers by announcing that each one of them is the owner of an acre and a third of forest land. Further, the reader

is told that he is the possessor of a hundred pine trees, twenty-five oaks, fifteen Douglas firs and varying numbers of true firs, cedars, spruce, hickories, poplars and aspens—two hundred trees in all. On the acre plus may also be found a fair share of chaparral, babbling brooks, rocks and clear mountain lakes. The National Forests belong to the people.

In the ensuing chapters Mr. Du Puy goes into the history of modern forestry and in an entertaining manner discusses the many problems that are being dealt with by the Forest Service, the most technical phases of forestry being presented in a fashion that makes them readily understandable to the layman. This same layman, incidentally, may or may not notice that the scene as depicted by this book is completely dominated by the U. S. Forest Service in spite of the fact that many other agencies actually enter into the picture. The reader may also note that in dealing with matters known to be highly controversial, the author presents but one side of the question—and presents it as gospel. Within its covers, this book contains most of the old familiar Forest Service dogma.

If one keeps one's fingers crossed, this book will prove to be an interesting addition to one's conservation library—and by all means look at the pictures.—*Gordon H. True, Jr., California Division of Fish and Game.*

Trout Streams: Conditions That Determine Their Productivity and Suggestions for Stream and Lake Management

By Paul R. Needham. Ithaca, N. Y., Comstock Publishing Co., 1938. 233 pp., 74 figs., bibliography, index. $3.00.

Everyone who is interested in trout—anglers, hatcherymen and conservation officials—will agree that in his book "Trout Streams," Dr. Needham has answered a long felt want. The author, who is an associate aquatic biologist with the U. S. Bureau of Fisheries, received during the course of the years he has been concerned with research on trout so many inquiries relating to trout, their food and their habitat, that he decided to put the answers down in print so that they would be available to the interested person. Fortunate for us, he did so. Here is a book replete with trout lore—not the rot that starts with the typical, "We crawled around the pool and Doc hopefully cast his HDH line with 4x leader and No. 10 Parmachene Belle . . .", nor is the text so unwieldy with long scientific terms as to be useless to the everyday reader.

The book starts out with concise descriptions of the trout and salmon, then describes the trout streams themselves. Next are excellent accounts of the stream inhabitants; predators, parasites and the host of small creatures used by the trout as food, particularly insects. There are several keys for the identification of the more important forms. The food habits of trout are related in the next section, followed by a chapter on the distribution of trout foods. The last fifty pages of the text are concerned with the conservation of the trout, including discussion of propagation methods, stocking policies, stream improvements —and measures of the desirability of the various aids to stream man-

agement. Throughout, the author rambles from one subject to another in a pleasing manner—a more precise arrangement would have become tiresome.

More interesting perhaps than the text is the appendix with a discussion of trout names, planting tables for streams and lakes, and a great deal of information on the organization and operation of stream and lake survey crews.

To many, the most agreeable feature of the book is its nationwide scope. The author is equally at home on the Ausable and the Klamath and draws impartially on his experiences in all parts of the United States—something rare indeed in books on fish and fishing.

The illustrations are both numerous and excellent.

After reading this book in mid-winter, all the reviewer can say is, "I would that summer were here!"—*Richard S. Croker, Editor, California Fish and Game.*

Fishing Memories

By Dorothy Noyes Arms; illustrations by William J. Schaldach. New York, Macmillan Co., 1938. 184 pp. $3.00.

In the literature of angling, a field dominated by men, there are few books that can equal the charm of this story written by a woman angler. Mrs. Arms recounts the highlights of a life-time of fishing in Maine, New Brunswick and Wyoming in a fascinating manner. Not concerned primarily with the catch itself or how it is made, the story tells of the things that make angling a game instead of a business—the little adventures of camp life, the beauty of trees and flowers, the shy animals glimpsed for a moment, the surprise at the sight of the first leaping salmon.

Mr. Arms, a dyed-in-the-wool fisherman since childhood, dragged his bride off on a camping trip at the first opportunity, and the experiment's margin between success and failure was narrow. The description of the moment when the bride decided fishing was worthwhile after all will bring back fond memories to many a wife-fisherwoman. From that point on, one pleasant memory follows another—the thrills of fighting salmon, running the river in a canoe, the speckled trout of a tiny brook, the cut-throat trout of the Rockies, even little perch in a pond. The writer has caught the spirit of fishing and put it into words that will bring joy to the fisherman and help him to pass the weary days between seasons.

The sixteen full-page drawings and the many head and tail pieces by Mr. Schaldach add much to the charm of the book. His scenes of camp life, fish in action, and the stream-side animals are fitting accompaniment to "Fishing Memories." The printing and binding are excellent.—*Richard S. Croker, Editor, California Fish and Game.*

Native Woody Plants of the United States, Their Erosion Control and Wildlife Values

By William R. Van Dersal. U. S. Department of Agriculture, Miscellaneous Publication, no. 303, 362 pp., 44 pls., index, 1938. $1.75 (buckram).

This welcome addition to game management literature by Van Dersal, Biologist for the Division of Conservation Operations, Soil Conservation Service, answers a long felt need for a publication dealing solely with trees and shrubs—the group of plants which is regarded as being of particular importance to the wildlife worker.

In introducing his subject, the author deals generally with the role that plants play in soil conservation and wildlife management and offers a number of suggestions for the selection of species for planting. Plant-Growth Regions are discussed at considerable length and maps are provided on which these regions are clearly delineated. Supplemental maps on which the climatic regions and the more important soil regions of the United States are outlined are to be found in the back of the book. The presentation of the Plant-Growth Region concept constitutes the reviewer's first and only opportunity to become familiar with it and he found the subject extremely interesting. Let this suffice for the introductory matter.

By far the greater part of the book is devoted to a list of the species of woody plants native to the continental United States and the California Islands. Groups such as the cacti and certain parasitic genera are not included. The species are listed alphabetically by their scientific names and for each species the following information is given: the common or vernacular name, range, type of location in which it grows, growth habit, fruiting habit, propagation, and its utilization by wildlife. Following this list are a rather complete bibliography of American trees and shrubs and an alphabetically arranged list of their common names.

If you are interested in the management of big game and wildfowl, by all means add this book to your collection. Write to the Superintendent of Documents, Washington, D. C.; $1.75, please.—*Gordon H. True, Jr., California Division of Fish and Game.*

Life Histories of North American Birds of Prey (Part 2)

By Arthur Cleveland Bent. U. S. National Museum. Bulletin, no. 170, 482 pp., 92 pls., index, 1938. $0.60.

Ever since the first part of "Life Histories of North American Birds of Prey" appeared in 1937, we have been impatiently awaiting the publication of this companion volume.

Part 1 dealt with the Cathartidae, the American vultures, and the Accipitriidae, the family to which the kites, hawks and their close allies belong. In Part 2, Bent considers the other large groups of North American predaceous birds: the family Falconidae, the caracaras and falcons, and the order Strigiformes which includes all of the North American species of owls.

The works of Arthur Cleveland Bent—compilations of all the available information concerning various groups of North American birds—should be on the book shelves of all bird lovers and students of fish and game management. Send sixty cents with your request to the Superintendent of Documents, Washington, D. C. Don't wait too long, for the Bent publications have the habit of going out of print with surprising rapidity.—*Gordon H. True, Jr., California Division of Fish and Game.*

In Memoriam

L. W. DINSDALE

Again we are faced with the necessity of having to announce the passing of another colleague in the ranks of the Division of Fish and Game, and it is with regret that we write that Warden L. W. Dinsdale passed away on January 25, 1939. His work of more than twelve years with the Bureau of Patrol and Law Enforcement has been noteworthy, especially in duck patrol, on which he was very well informed. The Division feels the loss of this man greatly and all those with whom he worked and who knew him will miss the friendliness and cooperative spirit of Mr. Dinsdale.

Mr. Dinsdale was born in the Sacramento Valley July 25, 1891, and spent his lifetime there, with the exception of the time he served with the United States Army during the World War. He entered the service of the Division of Fish and Game on July 29, 1926, with headquarters at Woodland, Yolo County. In October, 1927, he was transferred to Yuba City, where he was located until the time of his death.

We extend our heartfelt sympathy to his widow and children.—*E. L. Macaulay, Chief of Patrol, Division of Fish and Game.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1938, to December 31, 1938, of the Ninetieth Fiscal Year

Revenue for Fish and Game Preservation Fund:		
Current Year:		
License Revenue—		
Angling, 1939	$212 00	
Angling, 1938	386,790 50	
Angling, 1937	5,933 50	
Commercial hunting club, 1937-1938	950 00	
Commercial hunting club operators', 1937-1938	380 00	
Deer Tags, 1938	115,186 00	
Deer Tags, 1937	1,811 32	
Fish importers', 1939	35 00	
Fish breeders', 1939	170 00	
Fish breeders', 1938	10 00	
Fish packers' and wholesale shellfish dealers', 1938-1939	1,040 00	
Fish packers' and wholesale shellfish dealers', 1937	20 00	
Fish packers' and wholesale shellfish dealers', 1936	20 00	
Fishing party boat permits, 1939	2 00	
Fishing party boat permits, 1938	191 00	
Fish tag sales	2,122 00	
Game tag sales	335 46	
Game breeders', 1939	10 00	
Game breeders, 1938	165 00	
Hunting, 1938-1939	350,418 50	
Hunting, 1937-1938	14,757 00	
Kelp tax, 1938	20 00	
Market fishermen, 1938-1939	46,450 00	
Trapping, 1938-1939	1,214 00	
Trapping, 1937-1938	11 00	
Total licenses		$928,264 18
Other revenue:		
Court fines	$21,081 24	
Fish packers' tax	166,528 00	
Kelp tax	230 08	
Lease of kelp beds	52 80	
Miscellaneous sales	4,101 56	
Publications sales	7 50	
Salmon packers' tax	10,885 06	
Warrants cancelled, Chapter 815-35	8 50	
Total other revenue		$202,894 74
Total current year revenue		$1,131,158 92
Prior year (89th fiscal year):		
Angling, 1938	—$2 00	
Angling, 1937	—4 00	
Deer Tags, 1937	—10 00	
Hunting, 1937-1938	—278 00	
Trapping	—84 00	
Court fines	—225 00	
Total prior year		—$603 00
Grand total revenue		$1,130,555 92

STATEMENT OF EXPENDITURES

For the Period July 1, 1938, to December 31, 1938, of the Ninetieth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating Expenditures—90th Fiscal Year:					
Administration:					
Cashier	$750 00				$750 00
Executive	2,499 96	$161 91	$2,282 18		4,944 05
Exhibits	183 33		1,250 00		1,433 33
General office	3,924 20	1,187 20	23,738 72	$571 11	29,421 53
Library	960 00	8 54	63 33	43 98	1,075 85
Property inspection	1,020 00	87 26	311 15	18 10	1,436 51
Publicity			2,051 62		2,051 62
Total administration	$9,337 49	$1,444 91	$29,697 00	$633 49	$41,112 89
Patrol and Law Enforcement:					
Cannery inspection	$11,776 04	$176 68	$1,179 74		$13,132 41
Executive	5,969 85	454 09	1,272 50	$22 79	7,719 23
General office	3,000 00	531 33	357 06	552 22	4,440 61
Junior patrol	1,660 00	86 50	330 71		2,077 21
Land patrol	110,251 35	18,005 40	31,257 04	12,877 10	172,391 49
Marine patrol	36,936 99	9,345 32	20,307 95	3,096 70	69,686 96
Pollution patrol	5,360 00	927 46	2,073 11	334 75	8,695 32
Total patrol and law enforcement	$174,954 23	$29,526 73	$56,778 71	$16,883 56	$278,143 23
Marine Fisheries:					
Executive	$3,810 00	$90 75	$157 19		$4,057 94
Field supervision	1,650 00	136 80	471 25	$705 47	2,963 52
Fish cannery auditing			1,756 73		1,756 73
General office	5,340 19	233 67	339 26	54 51	6,176 63
Research and statistics	24,366 47	2,439 16	12,329 78	3,342 16	42,507 57
Total marine fisheries	$35,405 66	$2,900 38	$15,054 21	$4,102 14	$57,462 39
Fish Conservation:					
Biological survey	$5,500 00	$453 23	$1,047 54	$181 12	$7,181 89
Executive	3,480 00	65 38	151 28		3,696 66
Field supervision	2,760 00	528 36	1,018 08	135 69	4,442 13
Fish planting	1,400 00	916 08	2,397 36	4 71	4,718 81
Fish rescue	6,220 80	402 62	2,312 81	417 44	9,353 67
General office	2,580 00	25 49	26 61	382 85	3,014 95
Pollution inspection	2,250 00	316 24	410 45	803 34	3,780 03
Statistical	1,175 00	80 20	615 92		1,871 12
Stream improvements		100 55			100 55
Structural maintenance	1,998 39	475 00	692 94	811 55	3,977 88
Alpine Hatchery	1,434 84	506 65	100 13		2,041 62
Basin Creek Hatchery	2,440 13	784 08	214 86		3,439 97
Blue Lakes Egg Col. Station	380 00	114 81	8 85		503 66
Benbow Dam Exp. Station	533 33	56 09	187 76		778 08
Blackwood Hatchery	10 00		1 00		11 00
Big Creek Hatchery	1,860 00	1,317 41	92 15	281 77	3,551 33
Brookdale Hatchery	1,835 49	740 30	140 08	23 94	2,739 81
Burney Creek Hatchery	2,765 97	381 62	106 97	31 93	3,286 49
Carmen Lake Egg Col. Station	332 91		31 82		364 73
Central Valleys Hatchery	1,974 00	1,355 16	918 53	298 99	4,546 68
Cold Creek Hatchery		16 02	5 25		21 27
Cottonwood Lakes Egg Col. Station	230 40	23 45	102 00		355 94
Fall Creek Egg Col. Station	1,851 67	540 30	85 00		2,476 97
Fall Creek Hatchery	1,726 29	778 79	152 51	$7 08	2,744 67
Feather River Hatchery	2,315 99	561 77	866 42	12 24	3,756 42
Fern Creek Hatchery	$12 10	334 49	19 50		1,166 09
Forest Home Hatchery	3,774 35	653 01	613 54		5,040 93
Fort Seward Hatchery	2,407 58	1,224 81	322 18	74 35	4,028 72
Hat Creek Egg Col. Station			25 00		25 00
Hornbrook Egg Col. Station			75 00		75 00
Hot Creek Hatchery	1,744 19	1,381 10	123 97	15 95	3,265 21
Huntington Lake	1,582 59	305 11	238 63	26 75	2,133 08
Hobart Creek Egg Col. Sta.		8 70	20 50		29 20
June Lake Egg Col. Station			33 45		33 45
Kaweah Hatchery	2,083 06	429 00	543 83	36 98	3,092 87
Kings River Hatchery	1,008 85	561 17	117 13		2,287 15
Klamathon Egg Col. Station	1,205 80	272 48	593 79		2,072 07
Lake Almanor Hatchery	3,198 06	1,130 84	367 66		4,696 36
Lake Eleanor Egg Col. Station		9 48			9 48
Little Walker Lake Egg Col. Station	268 40		8 65		277 05
Little River Egg Col. Station	165 00	45 04	6 80	2 65	219 49
Lytle Creek Hatchery	199 33				199 33
Madera Hatchery	1,364 79	$02 47	148 91	9 18	2,325 35

STATEMENT OF EXPENDITURES

For the Period July 1, 1938, to December 31, 1938, of the Ninetieth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued:					
Marlette Lake Egg Col. Station	$665 23	$14 31	$23 80		$703 34
Mt. Shasta Exp. Hatchery	965 00	485 18	18 05		1,468 23
Mad River Egg Col. Station	100 00		15 32		115 32
Mount Shasta Hatchery	18,107 20	12,918 43	2,377 93	$266 10	33,669 66
Mount Tallac Hatchery	973 27	1,166 91	165 08	82 64	2,387 90
Mount Whitney Hatchery	6,411 97	2,861 39	1,649 76		10,923 12
Mud Creek Egg Col. Station	130 00	3 15			133 15
Mountain Home Hatchery	362 66	89 27		33 62	485 55
Prairie Creek Hatchery	2,967 33	1,525 40	439 93		4,932 66
Rush Creek Egg Col. Station	529 19		14 78		543 97
San Lorenzo Egg Col. Station	24 00	1 87	20 00		45 87
Shackleford Creek Egg Col. Station		11 25	50 00		61 25
Scott Creek Egg Col. Station	810 00	393 65	32 92		1,236 57
Shasta River Egg Col. Station	401 29	46 94	1 80		510 03
Shasta River Exp. Station	150 00		93 01		243 01
Snow Mountain Egg Col. Station	2,109 61	209 56	132 48		2,451 65
Tahoe Hatchery	3,260 00	1,002 21	218 70	10 52	4,491 43
Waddell Creek Station	660 00	77 02	27 43		764 45
Yosemite Hatchery	1,924 76	449 10	112 69	40 10	2,526 65
Yuba River Hatchery	1,717 15	342 00	183 78		2,242 93
Total fish conservation	$103,778 75	$39,596 34	$20,222 32	$4,071 49	$173,668 90
Hydraulics:					
Engineering	$3,180 00	$411 48	$1,036 36	$239 63	$4,867 47
Executive	2,010 00	178 65	420 71		2,609 36
Fish screens		469 34		17 30	486 64
General office	1,020 00	40 79	66 22	58 28	1,185 29
Total hydraulics	$6,240 00	$1,100 26	$1,523 29	$315 21	$9,178 76
Game Conservation:					
Elk refuge	$980 00	$182 58	$243 70	$508 64	$1,914 92
Executive	6,600 00	614 57	1,297 93	9 66	8,582 16
Game bird distribution, Los Serranos	2,550 00	422 53	438 39		3,440 92
Game bird distribution, Yountville	1,720 00	2,467 08	477 00		4,664 08
General office	2,037 00	42 14	16 77	251 60	2,347 51
Grey Lodge Refuge	2,140 00	402 87	178 26	8 24	2,789 37
Imperial Refuge	988 39	98 84	46 65		1,133 88
Los Banos Refuge	2,040 65	281 76	221 70	3,140 45	5,684 56
Los Serranos Game Farm	6,570 55	895 83	1,775 47	89 73	9,331 58
Los Serranos Boarding House	192 00	478 63	13 41		684 04
Predatory animal lion hunters	2,384 83	336 67	3,115 99	4 88	5,842 37
Predatory animal trapping	15,797 30	3,344 74	3,957 55	622 46	23,722 05
Refuge posting		4 41			4 41
Research	1,048 28	214 43	1,044 22	9 66	2,316 59
Statistics	1,127 10		521 73		1,648 83
Suisun refuge	1,493 53	220 32	232 92	37 86	1,984 63
Winter feeding and salting of game		30 25			30 25
Yountville Game Farm	7,544 38	3,123 32	1,280 60	734 70	12,682 00
Yountville Boarding House	617 70	854 64	23 70		1,496 04
Total game conservation	$55,021 71	$14,075 61	$14,894 99	$5,417 88	90,310 19
Licenses:					
Executive	$1,740 00	$116 27	$224 80	$12 72	$2,093 79
General office	726 43	98 33	137 46	514 75	1,476 97
License distribution	5,891 44	11,268 51	38,778 09	448 89	56,386 93
Total licenses	$8,357 87	$11,483 11	$39,140 35	$976 36	$59,957 69
Special Items:					
Construction of fish screens	$6,480 64	$8,090 22	$340 46	$1,648 36	$16,559 68
Construction of research boat	1,310 75			7,356 69	8,667 44
Improvement to office building, San Francisco				500 00	500 00
Total special items	$7,791 39	$8,090 22	$340 46	$9,505 05	$25,727 12
Total 90th fiscal year expenses paid from support appropriations					$735,561 17
Prior Year:					
89th fiscal year for support					37,376 58
Total 89th and 90th fiscal years for support:					$772,937 75

STATEMENT OF EXPENDITURES

For the Period July 1, 1938, to December 31, 1938, of the Ninetieth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Expenditures for Additions and Betterments:					
Permanent Improvements:					
Purchase of game refuges and public shooting grounds and C. I. E. 157-37, 90th fiscal year	$4,454 04	$7,400 04	$713 90	$5,440 23	$18,107 21
Contributions to Employees' Retirement System					14,612 19
Total current biennium					$805,657 15
Prior biennium appropriations:					
Special Item:					
Support:					
88th fiscal year					$46 00
87th fiscal year					33 00
86th fiscal year					40 00
Total support					$119 00
Grand total					$805,776 15

GAME CASES

October, November, December, 1938

Offense	Number arrests	Fines imposed	Jail sentences (days)
Antelope; possession horns and parts of hide	1	$50 00	
Bear; possession bear meat, closed season	3	75 00	
Commercial gun club, no license	1		
Deer; failure to tag, possession spike buck, deface and altering deer tag, evidence of sex removed, spot-lighting, failure to have tag validated, erasing deer tag, possession fawn, forked horn in District 1¾, closed district, possess female deer, take two deer in District 4¾, taking forked horn deer, possess used deer tag, allowing dogs to run deer, venison, closed season	159	4,106 50	1,076½
Doves; no license, shoot from auto, overlimit	22	280 00	
Ducks; possession in closed season, shoot before 7 a.m., possess wood ducks, selling ducks	163	3,834 50	408
Firearms; possession in refuge	42	515 00	102½
Fox; closed season, no license	1		
Game birds; shoot from powerboat, from auto, no license	12	260 00	
Geese; overlimit	32	440 00	
Grebe; killing	8	150 00	
Hunting; no license, closed season, at night, in game refuge, with another's license	56	920 00	175
Meadowlark; possession	1	10 00	
Mudhens; closed season	5	20 00	2½
Pheasants; closed season	73	2,075 00	190
Plover; possession	1	25 00	
Quail; closed season, no license, possess valley quail	39	731 00	19½
Rabbits; possession cottontails, closed season, hunting brush rabbits no license	16	180 00	2
Rail; killing	2	25 00	
Refuge; take mammal in refuge	1	100 00	
Robin; possession	5	100 00	
Shoot from public road	2	275 00	
Shore birds; taking, possession	13	325 00	
Squirrel; possession tree squirrel	1	25 00	
Swan; possession	4	80 00	
Trapping; no license	2	20 00	
Totals	665	$14,602 00	1,976

FISH CASES

October, November, December, 1938

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones; using diving apparatus to take, overlimit	39	$937 50	22
Angling; no license, false statement on license, within 150 feet of the lower side of dam, at night, other than with rod and line held in hand, within 250 feet of fish ladder, fail to show license on demand, too close to ladder, with illegal gear	65	998 00	38
Bass; striped, undersized, no license, taking between sunset and sunrise, night fishing	12	1,037 50	.....
Bluegill; possession overlimit	1	25 00	.....
Catfish; take with traps	1	.....	50
Clams; undersized, Pismo, overlimit	78	1,255 00	442
Commercial fishing; no license	28	220 00	60
Crabs; possession undersized	10	210 00	.....
Explosives; using to take fish	1	.....	.....
Fish; take from holding pond	2	25 00	11
Fyke nets; in closed waters, in Cache Slough, in Mukolumne River	6	462 50	.....
Gaff hooks; possess within 300 feet of stream, using in fish ladder	16	155 00	62½
Gill net; operate in Smith River, in District 1½	4	10 00	50
Lobsters; closed season, undersized, oversized	28	584 00	80
Operating fishing boat; no license	4	40 00	.....
Pollution	21	3,125 00	10
Purse seine; operate for purpose of taking fish from District 20	10	665 00	.....
Salmon; overlimit, spearing, take with gill net, closed season	67	744 00	362½
Sardines; no commercial license	1	15 00	.....
Set lines; in District 1	1	.....	7½
Spear; possess within 300 feet of stream, in District 1, possess on river	29	599 00	44½
Sunfish; no license	2	15 00	.....
Totals	456	$11,122 50	1,440

SEIZURES OF FISH AND GAME

October, November, December, 1938

Fish:	
Abalone	425
Abalone, lbs.	700
Bass, striped	11
Bluefin tuna, tons	3
Bluegillsunfish	83
Catfish, lbs.	127
Clams, Pismo	1,819
Clams, Pismo, lbs.	2
Clam rake	1
Crabs	80
Crab nets	2
Halibut, lbs.	40
Lobster	641
Rainbow trout	10
Salmon	110
Traps, lobster	64
Traps, bass	3
Trout	69
Game:	
Antelope horns	2
Avocets	1
Bears, brown	1
Bear meat, hind quarters	1
Bear skin	1
Bird net	8
Coots	1
Curlew, Hudsonian	13½
Deer	3,185½
Deer meat, lbs.	1
Deer skin	30
Doves	649
Ducks	106
Geese	5
Godwit, Hudsonian	6
Grebe	5
Killdeer	79
Pheasants	2
Pigeons	143
Quail	8
Rabbits, cottontails	6
Sandpiper	6
Shore birds	1
Squirrel, tree	4
Swan	

FRESH FISH LANDINGS OF CALIFORNIA BOATS

October, 1938

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Oregon and Washington waters		Waters south international boundary		Total landings of California boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 70, Los Angeles	Region 80, San Diego	Region 70, Los Angeles	Region 80, San Diego	
Anchovy						118,500		118,500					118,500
Barracuda					11,020	21,318	967	33,305			118,119	105,173	256,677
Cabezone				415				415					415
Cabrilla												7,447	7,447
Carp		571				290		861					861
Catfish		58,248						58,248					58,248
Cultus, Pacific	36,628		15,697	1,227	11	8		53,571					53,571
Flounder, Starry	10,473		27,675	580				38,728					38,728
Flying Fish						180		180					180
Grouper											261	6,793	7,054
Halibut, California			20	349	30,214	13,923	384	53,500			248	35,693	89,441
Halibut, Northern	3,753							3,753					3,753
Hardhead		420						420					420
Kingfish			33	20,333		17,182	38	37,586					37,586
Mackerel, Horse				27,323	399	6,263		33,985					33,985
Mackerel, Pacific				105,027	5,469	6,408,021	225,484	6,743,501				512	6,745,013
Mackerel, Spanish											932		932
Perch	90		4,503	200	54	4,366		9,213					9,213
Pike		55						55					55
Rock Bass				14	818	9,127	720	10,679			178	578	11,735
Rockfish	75,857		30,156	20,547	991	12,079	612	158,245			3,901	23,605	185,751
Sablefish	23,863		886			548		25,327					25,327
Sand Dab	17,828		10,682	277		305		29,392					29,392
Sardine		8,401,600	43,699,166	58,231,118		426,605	1,028	110,759,517				86	110,759,603
Scuplin						7,030	8,133	15,163					15,163
Sea-bass, Black					2,488	703	59	3,250			23,703	14,536	41,489
Sea-bass, White			2,863	409	13,146	5,281	902	22,601			22,196	36,090	80,887
Shark	15,929		514,911	11,320	8,112	10,833	1,636	562,741			229		562,970
Sheepshead					566	4,577	383	5,526			545	1,861	7,932
Skate	4,309		10,863	1,360	3,550	132		20,214					20,214
Smelt	3,033		9,649	12,255	1,755	21,159	2,260	50,111					50,111
Sole	478,865		217,887	5,209	20,521	70		722,552					722,552
Split-tail		1,124						1,124					1,124

Sucker		30						30					30
Swordfish, Broadbill					14,701	14,914	755	30,370			400	12,080	42,850
Tomcod			525					525					525
Tuna, Albacore			2,353	934,618	138,704	337,065	47,120	1,459,950	1,501,382	290,378			3,251,710
Tuna, Bluefin						14		14					14
Tuna, Bonito					10,906	677,320	3,690	691,916			142,509	38,127	872,952
Tuna, Skipjack						27	2,762	2,789			836,789	386,471	1,226,049
Tuna, Yellowfin							1,277	1,277			508,987	4,520,145	5,120,409
Turbot	45		5,344	360				5,749					5,749
Whitefish, Ocean					743	295	182	1,220			862	6,201	8,283
Yellowtail						302	273	575			2,344	37,767	40,686
Miscellaneous Fish	12,410		7,805	144	789	13,975		35,123			111		35,234
Crustacean:													
Lobster, Spiny					38,484	43,978	26,326	108,788				4,021	112,809
Shrimp			83,173	156				83,329					83,329
Mollusk:													
Abalone				7,550	36,812	793		45,157					45,157
Clam, Cockle			18			2,682		2,700					2,700
Clam, Gaper			180					180					180
Clam, Pismo				3,533	13,054			16,587					16,587
Clam, Soft-shell	147		7,341					7,488					7,488
Clam, Washington	3,133		72					3,204					3,204
Octopus			82	136		6		224					224
Oyster, Eastern	7,845		22,515					30,360					30,360
Oyster, Japanese			111,010		3,806			114,816					114,816
Oyster, Native			1,234					1,234					1,234
Squid				151,088		75		151,163					151,163
Total pounds	634,237	8,462,048	14,825,943	59,544,548	366,176	8,179,768	325,491	122,398,211	1,501,382	290,378	1,753,014	5,237,036	131,180,081

* The eight geographical regions of the State are as follows:
Regions 10 and 20, Del Norte and Eureka: Del Norte, Humboldt and Mendocino counties.
Region 30, Sacramento: Sacramento and San Joaquin river systems with the delta areas, including Suisun Bay and Lake County.
Region 40, San Francisco: Sonoma, Marin, San Francisco and San Mateo counties, including San Francisco and San Pablo bays.
Region 50, Monterey: Santa Cruz and Monterey counties.
Region 60, Santa Barbara: San Luis Obispo, Santa Barbara and Ventura counties.
Region 70, Los Angeles: Los Angeles and Orange counties.
Region 80, San Diego: San Diego and Imperial counties.

These tables are subject to slight revision due to belated supplemental items.

FRESH FISH LANDINGS OF CALIFORNIA BOATS

November, 1938

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Oregon and Washington waters		Waters south international boundary		Total landings of California boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 70, Los Angeles	Region 80, San Diego	Region 70, Los Angeles	Region 80, San Diego	
Anchovy			30,000			19,750		49,750					49,750
Barracuda					38,662	401	8	39,071			113,077	43,098	195,249
Cabezone				773				773					773
Cabrilla											21,781		21,781
Carp		1,291				240		1,531					1,531
Catfish		56,605						56,605					56,605
Cultus, Pacific	18,887		11,893	13,716		888		45,384					45,384
Flounder, Starry	400		40,442	2,942				49,784					49,784
Grouper											1,877	1,345	6,222
Hake	200							200					200
Halibut, California			219	703	35,572	7,764	7,280	51,538			46	7,278	58,862
Hardhead		5,003						5,003					5,003
Herring, Pacific			17,225				3,279	20,504					20,504
Kingfish			175	16,691	100	27,590	331	44,887					44,887
Mackerel, Horse				11,847		113,243		125,090					125,090
Mackerel, Pacific				47,329	2,346	5,527,231	739,092	6,315,998				21	6,316,019
Mackerel, Spanish											1,547	832	2,379
Mullet							1,344	1,344					1,344
Perch			4,520	90	21	8,701		13,332					13,332
Pike		64						64					64
Ratfish					1,555			1,555					1,555
Rock Bass					1,212	8,883	2,201	12,296			686	433	13,415
Rockfish	83,406		30,052	122,419	6,527	15,304	1,391	261,199			4,218	22,612	288,029
Sablefish	7,336		249	200		25,875		33,660					33,660
Salmon		2,160						2,160					2,160
Sand Dab	2,698		15,046	2,462		359		21,165					21,165
Sardine		10,700,000	43,903,397	63,621,176		70,781,869	4,862,016	193,958,458					193,958,458
Sculpin						5,008	6,362	11,370					11,370
Sea-bass, Black					169	1,320	255	1,744			4,112	23,794	29,650
Sea-bass, White			68	3,908	19,654	506	4,262	28,398			223	18,874	47,495
Shark	24,178		129,474	86,864	4,357	6,336	745	251,954				59	252,013
Sheepshead					18	9,379	262	9,659				459	10,118
Skate	5,310		14,311	2,493	3,232	323		25,669					25,669

Smelt	2,340		8,013	12,828	102	18,291	600	42,204				30	42,234
Sole	328,339		182,448	28,953	12,822	25		552,487					552,487
Split-tail		771						771					771
Swordfish, Broadbill						2,503		2,503					3,507
Tuna, Albacore				2,251	1,411	83,013	71,573	158,248	35,998	167,343		1,004	361,589
Tuna, Bonito					5,840	10,989	15,360	32,189			11,755	7,928	51,872
Tuna, Skipjack											88,840	10,462	99,302
Tuna, Yellowfin											185,830	3,531,566	3,717,205
Turbot			2,780	534		4		3,324					3,324
Whitebait				155				155					155
Whitefish, Ocean					220	927		1,147			1,022	2,872	5,041
Yellowtail							5,178	5,178			8,575	13,641	27,394
Miscellaneous Fish	11,925	10	6,986	455	1,188	7,220		27,784					27,784
Crustacean:													
Crab	1,476		452,240	19,200				472,916					472,916
Crab, Rock						10		10					10
Lobster, Spiny					13,940	25,437	10,891	50,268				109,526	159,794
Shrimp			89,889	1,078				90,967					90,967
Mollusk:													
Abalone				56,650	94,225	450		151,325					151,325
Clam, Cockle			91			1,719		1,810					1,810
Clam, Gaper			180					180					180
Clam, Pismo				2,596	12,360			14,956					14,956
Clam, Soft-shell	67		6,737					6,804					6,804
Clam, Washington	2,680		160					2,840					2,840
Octopus	106		20	1,988		12		2,135					2,135
Oyster, Eastern	9,288		13,216					22,504					22,504
Oyster, Japanese			124,425		3,028			127,453					127,453
Oyster, Native	145		1,518					1,663					1,663
Squid				489,368		75	384	489,827					489,827
Total pounds	498,681	10,855,904	45,033,328	64,549,669	258,561	76,712,648	5,733,014	203,701,805	35,998	167,343	446,358	3,795,634	208,147,378

* See footnote to table for October.

FRESH FISH LANDINGS OF CALIFORNIA BOATS

December, 1938

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Waters south international boundary			Total landings of California boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	
Anchovy						197,243		197,243				197,243
Barracuda							384	384	40,200	88,996	16,703	155,283
Cabezone				581				581				581
Cabrilla										22,322	20,238	42,560
Carp		1,757						1,757				1,757
Catfish		31,056						31,056				31,056
Corbina, Mexican										721		721
Cultus, Pacific	9,822		4,710	19,576		22	23	34,153				34,153
Flounder, Starry	140		5,901	3,675				9,716				9,716
Grouper										12,969	16,816	29,785
Hake			600					600				600
Halibut, California			1,248	1,884	21,978	8,518	8,905	42,533			3,204	45,737
Hardhead		3,264						3,264				3,264
Herring, Pacific			77,447				60	77,507				77,497
Kingfish			35	19,591	21	28,968	20	49,035				49,035
Mackerel, Horse				3,235		418,472		421,707				421,707
Mackerel, Pacific				29,930	2,951	13,533,911	912,291	14,479,083		255	376	14,479,714
Mackerel, Spanish										1,802	321	2,123
Mullet						32	50	82				82
Perch			3,744	3,058		2,317		9,119				9,119
Pike		80						80				80
Ratfish					295	18		313				313
Rock Bass					5,177	2,747	281	8,205		1,592	1,001	10,798
Rockfish	26,538		31,287	144,338	17,343	28,215	6,786	254,507			11,710	266,217
Sablefish	1,105		115	310		4,890		6,420				6,420
Salmon		11,911						11,911				11,911
Sand Dab	918		25,672	1,806		412		28,808				28,808
Sardine		10,551,400	100,789,110	64,158,552		76,478,040	93,560	261,071,262				261,071,262
Sculpin					134	4,444	4,928	9,506				9,506
Sea-bass, Black					320		232	552		2,639	23,783	26,974
Sea-bass, White			27	311	16,445	18,158	1,723	36,664		40	10,160	46,864
Shark	28,051		548,978	170,658	1,913	2,064	669	752,333			74	752,407
Sheepshead					1,844	6,210	129	8,183		247	1,210	9,646
Skate	1,500		29,624	1,781	3,245	351	100	36,661				36,661

Smelt	150		7,754	18,328	552	14,021		40,805				40,805
Sole	58,175		440,503	15,932	11,044	128		526,082				526,082
Split-tail		1,200						1,200				1,200
Tomcod			350					350				350
Tuna, Bonito					513	13,227	988	14,728			2,357	17,085
Tuna, Skipjack											5,875	5,875
Tuna, Yellowfin							57	57		599,503	2,090,428	2,689,988
Turbot			5,403	555				5,958				5,958
Whitebait	36			200				236				236
Whitefish, Ocean					1,184	2,425		3,609		77	2,838	6,524
Yellowtail							35	35		1,517	66,958	68,510
Miscellaneous Fish	1,850		9,287		1,067	17,820	55	30,080		234		30,323
Crustacean:												
Crab	23,060		421,090	121,720				565,870				565,870
Crab, Rock						42		42				42
Lobster, Spiny					14,473	32,598	9,499	56,570			206,155	262,725
Shrimp			70,551	1,012				71,563				71,563
Mollusk:												
Abalone				17,800	33,200	525		51,525				51,525
Clam, Cockle			27			1,546		1,573				1,573
Clam, Gaper			180					180				180
Clam, Pismo				907	10,789			11,696				11,696
Clam, Soft-shell	83		7,056					7,139				7,139
Clam, Washington	2,113		234					2,347				2,347
Octopus	80			2,641		29		2,750				2,750
Oyster, Eastern	9,361		28,048					37,409				37,409
Oyster, Japanese			175,150		3,610			178,760				178,760
Oyster, Native			2,014					2,014				2,014
Squid				47,990		4,890	4,064	56,944				56,944
Total pounds	103,352	19,600,677	102,686,145	64,786,771	148,098	90,822,883	1,044,829	279,252,755	46,200	732,914	2,483,213	282,515,082

* See footnote to table for October.

FRESH FISH IMPORTATIONS FROM OTHER STATES AND FOREIGN COUNTRIES

October, 1938

	Oregon and Washington	Gulf of California	Japan
For canneries:			
Tuna, Albacore	949,161		
For fresh fish markets:*			
Cabrilla		432	
Corbina, Mexican		109	
Sea-bass, Totuava		142,002	
Total pounds	949,161	142,543	

November, 1938

	Oregon and Washington	Gulf of California	Japan
For canneries:			
Tuna, Albacore	150,062		
For fresh fish markets:*			
Cabrilla		1,162	
Corbina, Mexican		4,007	
Sea-bass, Totuava		175,151	
Total pounds	150,062	180,320	

December, 1938

	Oregon and Washington	Gulf of California	Japan
For canneries:			
Tuna, Skipjack			102,701
For fresh fish markets:*			
Cabrilla		4,316	
Corbina, Mexican		12,042	
Sea-bass, Totuava		223,662	
Total pounds		240,020	102,701

* This record includes only that fish which is voluntarily reported to the Division of Fish and Game and does not represent all importations.

Figures for importations of albacore from Oregon and Washington include fish caught by a few California boats temporarily operating and landing their catches in those states.

69800 5-39 3200

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief ..... San Francisco
Clarence Elliger, Assistant Hydraulic Engineer ..... San Francisco
Byron Wittorff, Assistant ..... San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief ..... Sacramento
J. J. Shannon, License Agent ..... Sacramento
L. O'Leary, License Agent ..... San Francisco
R. Nickerson, License Agent ..... Los Angeles

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol ..... San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

LaRue Chappell, Inspector in Charge ..... Sacramento

Northern Division

Jos. H. Sanders, Captain in Charge ..... Sacramento
Don Chipman, Warden, Flying Squad ..... Dunsmuir
Wm. La Marr, Warden, Flying Squad ..... Nevada City
Eugene Durney, Assistant Warden, Flying Squad ..... Sacramento
A. H. Willard, Captain ..... Nevada City
A. A. Jordan, Captain ..... Redding
Chas. Sibeck, Warden, Launch *Perch* ..... Sacramento
L. M. Booth, Assistant Warden, Launch *Perch* ..... Sacramento
E. J. Johnson, Warden, Plumas County ..... Quincy
L. E. Mercer, Warden, Butte County ..... Chico
Taylor London, Warden, Colusa County ..... Colusa
Albert Sears, Warden, El Dorado County ..... Placerville
E. C. Vail, Warden, Glenn County ..... Willows
C. O. Fisher, Warden, Lassen County ..... Susanville
Don Davison, Warden, Modoc County ..... Alturas
Earl Hiscox, Warden, Nevada County ..... Nevada City
Nelson Poole, Warden, Placer County ..... Auburn
J. E. Hughes, Warden, Sacramento County ..... Sacramento
H. S. Vary, Warden, Sacramento County ..... Sacramento
Earl Caldwell, Warden, Shasta County ..... Burney
Chas. Love, Warden, Shasta County ..... Redding
A. Granstrom, Warden, Sutter County ..... Yuba City
Brice Hammack, Warden, Siskiyou County ..... Yreka
Fred R. Starr, Warden, Siskiyou County ..... Dorris
W. J. Black, Warden, Solano County ..... Suisun
R. W. Anderson, Warden, Tehama County ..... Red Bluff
C. L. Gourley, Warden, Trinity County ..... Weaverville
R. L. Sinkey, Warden, Yolo County ..... Woodland
R. A. Tinnin, Warden, Yuba County ..... Browns Valley
R. E. Tutt, Warden, Sierra County ..... Downieville

Southern Division

S. R. Gilloon, Captain in Charge ..... Fresno
J. W. Thornburg, Warden, Flying Squad ..... Tracy
John O'Connell, Captain ..... Stockton
E. O. Wraith, Captain ..... Bakersfield
R. J. Little, Warden, Amador County ..... Jackson
L. R. Garrett, Warden, Calaveras County ..... Murphys
F. A. Bullard, Warden, Fresno County ..... Reedley
Paul Kehrer, Warden, Fresno County ..... Fresno
Lester Arnold, Warden, Kern County ..... Bakersfield
Roswell Welch, Warden, Kern County ..... Kernville
Ray Ellis, Warden, Kings County ..... Hanford
H. E. Black, Warden, Madera County ..... Madera
Gilbert T. Davis, Warden, Mariposa County ..... Mariposa
M. S. Clark, Warden, Merced County ..... Merced
C. S. Donham, Warden, Merced County ..... Gustine
Wm. Hoppe, Warden, San Joaquin County ..... Lodi
Geo. Magladry, Warden, Stanislaus County ..... Modesto
R. J. Bullard, Warden, Tulare County ..... Porterville
W. I. Long, Warden, Tulare County ..... Visalia
F. F. Johnston, Warden, Tuolumne County ..... Sonora

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge ..... San Francisco

Northern Division

W. J. Harp, Captain in Charge ..... Ukiah
R. Remly, Warden, Flying Squad ..... Willits
J. D. Dondero, Captain ..... Eureka
Henry Lencioni, Captain ..... Santa Rosa
Ray Diamond, Warden, Del Norte County ..... Crescent City
John Hurley, Warden, Humboldt County ..... Eureka
W. F. Kaffner, Warden, Humboldt County ..... Fortuna
Scott Feland, Warden, Lake County ..... Lakeport
R. J. Yates, Warden, Marin County ..... San Rafael
Ovid Holmes, Warden, Mendocino County ..... Fort Bragg
Leo Mitchell, Warden, Mendocino County ..... Point Arena
J. W. Harbuck, Warden, Napa County ..... Napa
Bert Lawe, Warden, Sonoma County ..... Petaluma
Victor Von Arx, Warden, Sonoma County ..... Santa Rosa

Southern Division

Wm. Lippincott, Captain in Charge ..... San Francisco
Owen Mello, Warden, Flying Squad ..... San Jose
O. P. Brownlow, Captain ..... Alameda
_____, Captain ..... Salinas
C. L. Bundock, Warden, Alameda County ..... Oakland
Ed Clements, Warden, Contra Costa County ..... Martinez
Orben Philbrick, Warden, Monterey County ..... King City
F. H. Post, Warden, Monterey County ..... Salinas
J. P. Vissiere, Warden, San Benito County ..... Hollister
Lee C. Shea, Warden, San Francisco County ..... San Francisco
E. W. Hecker, Warden, San Luis Obispo County ..... San Luis Obispo
C. R. Peek, Warden, San Mateo County ..... San Mateo
C. E. Holladay, Warden, Santa Clara County ..... San Jose
F. J. McDermott, Warden, Santa Cruz County ..... Santa Cruz

Marine Fisheries Detail (Coast District)

Ralph Classic, Captain ..... Monterey
Kenneth Hooker, Warden, Cruiser *Quonset III* ..... San Francisco
Nathan Rogan, Assistant Warden, Cruiser *Quonset III* ..... San Francisco
C. Apsley, Assistant Warden, Launch *Sturgeon* ..... Martinez
J. W. Cowan, Assistant Warden, Launch *Sturgeon* ..... Martinez
Leslie E. Lahr, Warden ..... Eureka
Charles Mayfield, Warden ..... Monterey
G. R. Smalley, Warden ..... Richmond
Ralph Miller, Warden ..... San Francisco
Charles Holzhouser, Warden ..... Watsonville

SOUTHERN DISTRICT (Headquarters, Los Angeles)

C. S. Bauder, Inspector in Charge ..... Los Angeles
E. H. Ober, Captain, Special Duty ..... Los Angeles

Western Division

_____, Captain in Charge ..... Los Angeles
Theo. Jolley, Warden, Flying Squad ..... Los Angeles
Walter Shannon, Warden, Flying Squad ..... Los Angeles
Earl Macklin, Captain ..... Santa Barbara
L. T. Ward, Captain ..... Escondido
James Loundagin, Warden, Imperial County ..... Brawley
Fred Albrecht, Warden, Los Angeles County ..... Los Angeles
W. L. Hare, Warden, Los Angeles County ..... San Fernando
Walter Emerick, Warden, Orange County ..... Santa Ana
E. H. Glidden, Warden, San Diego County ..... San Diego
A. R. Ainsworth, Warden, Santa Barbara County ..... Santa Maria
R. E. Bedwell, Warden, Santa Barbara County ..... Santa Barbara
G. N. Johnson, Warden, Ventura County ..... Ventura

Eastern Division

H. C. Jackson, Captain in Charge ..... San Bernardino
A. L. Stager, Warden, Flying Squad ..... San Bernardino
_____, Captain ..... Bishop
_____, Captain ..... Banning
E. L. Walker, Warden, Inyo County ..... Bishop
C. J. Walters, Warden, Inyo County ..... Independence
Al Crocker, Warden, Mono County ..... Bridgeport
J. H. Gyger, Warden, Riverside County ..... Perris
R. C. O'Conner, Warden, Riverside County ..... Banning
W. C. Malone, Warden, San Bernardino County ..... San Bernardino
W. S. Talbott, Warden, San Bernardino County ..... Big Bear Lake

Marine Fisheries Detail (Southern District)

C. H. Groat, Captain in Charge
Lars Weseth, Master, M. V. *N. B. Scofield*—Terminal Island
Walter Engelke, Master, M. V. *Bluefin*—Terminal Island
Howard V. Shebley, Warden, Cruiser *Bonito*—Terminal Island
Kenneth Webb, Assistant Warden, Cruiser *Bonito*—Santa Barbara
John Spicer, Warden, Cruiser *Broadbill*—Santa Barbara
L. R. Metzgar, Assistant Warden, Cruiser *Broadbill*—Santa Monica
_____, Warden, Cruiser *Marlin*—Santa Monica
Niles Millen, Assistant Warden, Cruiser *Marlin*—San Diego
Carmi Savage, Warden, Cruiser *Tuna*—San Diego
John Barry, Assistant Warden, Cruiser *Tuna*—Avalon
E. R. Hyde, Warden, Cruiser *Yellowtail*—Avalon
H. Ocker, Assistant Warden, Cruiser *Yellowtail*—Balboa
Lester Golden, Warden—Balboa
T. J. Smith, Warden—Arroyo Grande
E. A. Chan, Warden—San Diego
Donald Glass, Warden—Terminal Island
Erol Greenleaf, Warden—Terminal Island
N. C. Kunkel, Warden—Terminal Island
Tate F. Miller, Warden—Terminal Island
T. W. Schilling, Warden—Terminal Island
L. G. Van Vorhis, Warden—Terminal Island

POLLUTION DETAIL

Paul Shaw, Chemist in Charge—San Francisco
C. L. Towers, Warden—Los Angeles
Jack McKerlie, Warden—Oakland
J. A. Reutgen, Assistant Warden, Launch *Rainbow*—Stockton
R. Schoen, Warden—Terminal Island
H. A. Erwick, Assistant Warden—Terminal Island
E. A. Johnson, Assistant Warden—Terminal Island

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol—San Francisco
Robert Cowell, Warden, Junior Game Patrol—San Francisco
Geo. D. Seymour, Assistant, Junior Game Patrol—San Francisco

MARINE PATROL AND RESEARCH

Motor Vessel *N. B. Scofield*, Terminal Island
Motor Vessel *Bluefin*, Terminal Island
Cruiser *Yellowtail*, Newport Harbor
Cruiser *Broadbill*, Santa Monica
Cruiser *Quinnat III*, San Francisco
Cruiser *Bonito*, Santa Barbara
Cruiser *Marlin*, San Diego
Cruiser *Tuna*, Avalon
Launch *Rainbow*, Stockton
Launch *Shrapnel*, Lakeport
Launch *Sturgeon*, Martinez
Launch *Perch*, Sacramento

printed in CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO: GEORGE H. MOORE, STATE PRINTER
1939